Fluid Mechanics I
Fall 2020 - MAAE 2300
Course Outline

Instructors:

- **Section A:** Dr. Fidel Khouli, Office: ME 3246 , ✉: `Fidel.Khouli@carleton.ca` , ☎: (613) 520 - 2600 ext 5783
- **Section B:** Dr. Nafisa Bano, ✉: `Nafisa.Bano@carleton.ca`
- **Section C:** Dr. Reza Kholghy, Office: CB 3202, ✉: `Reza.Kholghy@carleton.ca` , ☎: (613) 520 - 2600 ext 7119

Lectures:

Asynchronously Delivered: Pre-recorded lectures will be posted on the cuLearn page of the course at least 24hrs before the scheduled lecture time. The scheduled meeting time will be utilized as live sessions with the instructor to answer questions about the lecture, review certain concepts, solve additional problems, hold office hours and conduct midterms.

- **Section A:** Monday & Wednesday, 8:35 - 9:55
- **Section B:** Tuesday & Thursday, 13:05 - 14:25
- **Section C:** Monday & Wednesday, 10:05 - 11:25

Problem Analysis Sessions:

Synchronously Delivered: Students are expected to be available during their PA session meeting time, which will be synchronously delivered and recorded.

- L1: Monday, 11:35 - 14:25 - BigBlueButton
- L2: Wednesday, 11:35 - 14:25 - BigBlueButton
- L3: Thursday, 14:35 - 17:25 - BigBlueButton
- L4: Tuesday, 14:35 - 17:25 - BigBlueButton
- L5: Wednesday, 14:35 - 17:25 - BigBlueButton
- L6: Friday, 8:35 - 11:25 - BigBlueButton
- L7: Friday, 14:35 - 17:25 - BigBlueButton

Graduate Attributes

Knowledge Base: Develop sufficient engineering knowledge and competency in the principles that underpin fluid mechanics [40%]; Problem Analysis: Develop appropriate knowledge and skills to identify, formulate, analyze, and solve engineering fluid mechanics problems in order to reach substantiated conclusions [40%]; Investigation: Use of experiments, analyze and interpret experimental data to achieve valid conclusions [20%].

Teaching Assistants:

TBA on cuLearn

Course Description:

Fluid Mechanics is one of the most interesting and widely applicable subject areas in all of engineering. Familiar examples and applications include diverse topics such as aerodynamics (e.g. flight, lift, and drag); weather; biology (circulation, breathing, etc.); transportation (combustion, vehicle design); water transport; hydroelectric power, wind-turbines, pollutant dispersion, along with numerous other fascinating and important areas. In this course, we will first introduce basic concepts of fluids and fluid mechanics. We will consider fluids at rest and in motion and we will develop powerful governing equations using the control volume approach. We will give particular attention to developing useful forms of linear momentum and energy equations to study fundamental and practical applications of fluid mechanics in engineering problems. Laboratory experiments will also provide "hands-on" examples and experience to complement the lecture material.

Course cuLearn Page:

The course has its own webpage in cuLearn where recorded lectures, recorded problem analysis sessions, recorded lab sessions, lecture slides, BigBlueButton session links, suggested problems laboratory manual, laboratory information and midterm solutions are posted. Students must regularly check the course cuLearn website for important announcements and possible handouts.

Prerequisites:

Second-year status in Engineering and:

- MATH 1005: Differential Equations and Infinite Series for Engineering Students.
- MATH 1104: Linear Algebra for Engineering and Computer Science Students.
- ECOR 1101: Mechanics I

Textbook:

The course is assigned the following textbook, which is available in the bookstore: *David A. Chin*, FLUID MECHANICS FOR ENGINEERS, First Edition, PEARSON, 2016 (ISBN 978-0133803129).

Additional References:

- *C.T. Crowe, D.F. Elger, and J.A. Roberson*, "Engineering Fluid Mechanics", 9^{th} Ed., John Wiley & Sons, 2008 (ISBN 978-0470259771).
  An introductory text aimed at both 2nd and 3rd year students. Coverage and explanations of introductory concepts and material is generally very good and examples tend to focus on problem solving. Although, it may not be as useful as the course textbook as a long-term reference, it might be better as a first introduction to fluid mechanics (**On Reserve in Library**).
- *R.W. Fox, A.T. McDonald, and P.J. Pritchard*, "Introduction to Fluid Mechanics", 7^{th} Ed., John Wiley & Sons, 2008 (ISBN 978-0471742996).
  Another widely used introductory text. The content is similar to that of the course textbook, and there is an emphasis on problem solving in the text (**On Reserve in Library**).
- *F. M. White*, "Fluid Mechanics", 8^{th} Ed., McGraw Hill, 2016 (ISBN 978-9385965494).
  Another widely used comprehensive and advanced reference. Advanced courses in Fluid Mechanics usually use it as a primary reference (**On Reserve in Library**).
- *Yunus A. Cengel, John M. Cimbala*, "Fluid Mechanics: Fundamentals and Applications", Student Ed., McGraw Hill, 2017 (ISBN 978-1260152067).
  Another widely used introductory text. The content is similar to that of the course textbook (**On Reserve in Library**).

Grading:

- Closed book and notes first *optional* midterm exam (15%). The first *optional* midterm is scheduled for **Sections A &C:** Wednesday, October 14, 2020, **Section B:** Thursday, October 15, 2020. The midterm will be conducted online through cuLearn.
- Closed book and notes second *optional* midterm exam (15%). The second *optional* midterm is scheduled for **Sections A &C:** Monday, November 16, 2020, **Section B:** Tuesday, November 17, 2020. The midterm will be conducted online through cuLearn.
- Laboratory Experiments (20%).
- Final Examination (50%).

This course has two optional midterms; however, students are encouraged to participate in the midterms to improve their final grade and reduce the grade weight of the final examination. Depending on your participation in the optional midterms, the following grading schemes and rules will be applicable:

♣ Participation in one midterm only will render the grade weight of the final exam to be 65%. If you receive 80% and above in your only one midterm, you will receive a 0.5 (half a letter grade) bonus in your final letter grade in the course.

♣ Participation in two midterms will render the grade weight of the final exam to be 50%. If you receive 75% and above per midterm test or in the average of the two tests, you will receive a 1.0 (full letter grade) bonus in your final letter grade in the course.

♣ No participation in any midterm will render the grade weight of the final exam to be 80%.

♣ Students are not allowed to use information found on internet resources in ANY form or communicate with others in ANY format during the midterms and final exam.

♣ Students are allowed one handwritten formula sheet two-sides in the midterms and the final exam.

General Guidelines:

♣ The midterms and the final examination are knowledge testing and problem solving oriented. They cover all parts of the course taught by the time of the examination.

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

♣ The final examination is for evaluation purposes only and exam questions are not supposed to be shared with the students after the conclusion of the examination. **You must pass the final exam to pass the course.**

♣ Only non-communicating and non-programmable calculators can be used during the midterm and the final exam.

Laboratory Experiments:

All students will be **required** to observe and analyze **two laboratory experiments**, as described in the course manual. The experiments are already recorded and the recordings along with the collected data will be posted for each experiment on the cuLearn page of the course on the first day of the week of the experiments according to the Laboratory Schedule shown below. The TAs and the instructors will be available to answer your questions regarding the labs via email and the chat forum in cuLearn. The late start to the laboratory exercises is to enable most of the theory needed in the laboratory to have been covered in lectures.

- Students will be required to electronically submit their laboratory reports using the submission portal in the cuLearn page of the course exactly one week after the posting of the laboratory exercise and associated data.

- Students must include the name of the TA, PA/Lab session number and date the experiment was posted on the cover sheet.
- **Each student must perform data analysis and prepare his/her own Laboratory Report individually. Sharing data analysis or copying reports in parts or in full from others or the internet means plagiarism and will constitute an academic offence.**
- See the section on Laboratory Exercises in the course manual for details on laboratory report preparation.
- **According to University guidelines, students who have completed the lab sessions in a previous year, will no longer get laboratory exemption. This means that ALL students registered in the class this term have to complete the laboratory experiments, no matter whether they take the course first time or they repeat it.**

Week of	**Experiment**
November 16	1
November 23	2

MAAE 2300, Fall 2020 - Laboratory Schedule

Lecture Topics:

Weeks of	Lecture	Topic	Description	Text Ch
W1-(Sept 7-11)	1	Course Organization	Syllabus; Administration; Midterms; Labs	Course Outline
W2-(Sept 14-18)	2	Introduction: Concept of Fluid; Fluid Properties, Units & Dimensions	Compressibility; Normal/Tangential Stress; Continuum Approximation; SI and USCS Units; Significant Digits; Conversion Between Units; Density; Viscosity and No Slip Condition; Surface Tension	Ch 1
	3			
W3-(Sept 21-25)	4	Begin **Fluid Statics:** Pressure & Shear Stress; Pressure Distribution	Spatial Distribution of Pressure; Manometry; Absolute vs Gauge Pressure; Hydraulic Machinery	Ch 2.1-2.2
	5	The Atmosphere; Pressure Measurements	Change of Pressure with Altitude; Barometers; Manometers; Gauges	Ch 1.5, 2.2-2.3
W4-(Sept 28-Oct 2)	6	Forces on Submerged Surfaces	Forces on Plane and Curved Surfaces; Centre of Pressure	Ch 2.4-2.5
	7	Submerged Bodies	Buoyancy & Archimedes Principle; Floating Stability & Meta-Centre	Ch 2.6
W5-(Oct 5-Oct 9)	8	Rigid Body Motion: Linear	Fluid Undergoing Constant Linear Acceleration	Ch 2.7.1
	9	Rigid Body Motion: Angular	Fluid Undergoing Constant Angular Acceleration	Ch 2.7.2
W6-(Oct 12-16)	10	Begin **Fluid Dynamics:** Introduction to Fluid Dynamics	Kinematics; Flow Rate; Viscosity Effects; Shear Stress; Boundary Layer	Ch 3.1,3.2
	11	Fluid Flow Analysis	Control Volume Analysis; Types of Flow; Pathlines; Streamline; Streakline	Ch 3.2
W7-(Oct 19-23)	12	Reynold's Transport Theorem - Mass	Mass Conservation; Steady Flow; Applications: Multiple Inlets/Outlets; Accumulation of Fluid	Ch 4.3
	13			
Fall Break (Oct 26-30)				

MAAE 2300, Fall 2020 - Topics Schedule

Continue - Lecture Topics:

Weeks of	Lecture	Topic	Description	Text Ch
W8-(Nov 2-6)	14	Reynold's Transport Theorem: Linear Momentum	Linear Momentum to Analyze Forces on Fluids: Internal and External, Conservation of Momentum	Ch 4.4
	15			
W9-(Nov 9-13)	16	Bernoulli's Equation	Idealized Fluid Flow; Pressure Changes; Stagnation Pressure	Ch 3.3
	17	Applications of Bernoulli's Equation	Measurement of Flow Rate: Inlet, Venturi, Orifice Meter, Stagnation Tube	
W9-(Nov 16-20)	18	Reynolds Transport Theorem – Energy	Head; Static Head; Dynamic Head; Elevation Head; Pump/Turbine Head; Head Loss	Ch 4.6
	19	Viscous Flow & Moody Charts	Reynolds Number; Viscous Effects; Flow Regimes; Minor Losses: Bends, Valves, Expansions/Contractions	Ch 7.1-7.5
W11-(Nov 23-27)	20	Reynolds Transport Theorem – Angular Momentum	Angular Momentum for a Control Volume; Angular Velocity; Acceleration; Coriolis Acceleration	Ch 4.5
	21	Applications of Angular Momentum	Devices and Effects of Fluids Undergoing Rotation; Pumps and Fans	
W12-(Nov 30-Dec 4)	22	Applications & Review	Review of Course Content	
	23			

Continue: MAAE 2300, Fall 2020 - Topics Schedule

Problem Analysis Sessions with TAs:

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 and the scheduled lecture times. However, the range of possible problems in fluid mechanics is enormous. Possible problems cannot be categorized into few "standard" types. To develop the necessary understanding and proficiency in solving problems, it is essential to do a substantial number of problems and to do them relatively independently. **Practice problems will be posted on a weekly basis on Friday evening in cuLearn**. The practice problems will be addressed during the Problem Analysis sessions of the week that follows their posting, where the TAs will pick four problems to solve interactively online during the PA session. Although these practice problems are not marked, students are encouraged to solve all problems to practice for the midterm and the final exams. The difficulty of the examinations will be similar to the difficulty of the practice problems. You are encouraged to discuss the solutions with your TA once you are finished with your assignment problems.

Additional Information:

- Unless approved by the instructor, distribution of recorded lectures, laboratories and PA sessions outside the realm of students registered in MAAE 2300 during the Fall 2020 semester is prohibited.
- Students must pass the final examination to pass the course.
- Assignment problems will be posted on cuLearn but they will not be marked. Students are expected to fully participate in the Problem Analysis (PA) sessions where the assignment problems will be reviewed and questions answered.
- Due to a new regulation recently passed by the University Senate, students who withdraw from any course after the full fee adjustment date (September 30, 2020 for Fall 2020) will have a WDN for that course appear on their official and unofficial Carleton University transcripts.
- It is an instructional offence to use or pass off as one's own idea which is the work of another without expressly giving credit to that other. It is also an instructional offence to copy the work of a fellow student. If students do plagiarize or cheat, the Dean's office will be notified and appropriate action will be taken.

Academic Accommodation:

You may need special arrangements to meet your academic obligations during the term. For an accommodation request the processes are as follows:

Pregnancy obligation: write to me 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. For more details see the Student Guide (http://www2.carleton.ca/equity/accommodation/academic/students/).

Religious obligation: write to me 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. For more details see the Student Guide (http://www2.carleton.ca/equity/accommodation/academic/students/).

Academic Accommodations for Students with Disabilities: The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website for the deadline to request accommodations for the formally-scheduled exam (if applicable).