

## MAAE 2300: Fluid Mechanics I

(SECTIONS B, C, D and F WINTER 2014)

### COURSE OUTLINE

#### Instructors and Course Schedule:

	Section B	Section C	Section D	Section F
	Dr. John Gaydos	Dr. Daniel Feszty (Course Coordinator)	Dr. Oren E. Petel	Dr. Vinh Q. Tang
Lectures:	Mondays, Wednesdays 16.05 – 17.25 Minto Centre 5050	Mondays, Wednesdays 13.05 – 14.25 Azrieli Theatre 102	Wednesday, Friday 10.05 – 11.25 Steacie Building 103	Tuesdays, Thursdays 13.05 – 14.25 Loeb Building C164
Office Hours:	After classes	After classes	To be announced later	Before classes by appointment
Phone:	613 520-2600 ext.8282	613 520-2600 ext.5783	613 520-2600 ext. 2059	
Email:	jgaydos@mae.carleton.ca	oren.petel@carleton.ca	vinh.tang@Carleton.ca	
Office:	ME 3246	CB 3207	ME 3230C	ME2186

#### Teaching Assistants:

To be announced later.

#### 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, using control volume analysis, we will develop powerful governing equations. We will give particular attention to developing useful forms of linear momentum and energy equations to study fundamental and practical applications of fluids mechanics in engineering problems. Laboratory experiments will also provide “hands-on” examples and experience to complement the lecture material.

**Prerequisites:**

MATH1005: Differential Equations and Infinite Series for Engineering Students  
MATH1104: Linear Algebra for Engineering and Computer Science Students  
ECOR 1101: Mechanics I

**Course Website:**

Additional course material, laboratory sign-up sheets, problems, and term grades will be posted using CULearn.

**Course Materials:**

The Laboratory Manual as well as the Problem Sets for the Problem Analysis Sessions are available in downloadable PDF format on CULearn.

**Recommended Texts:**

There are several good texts on undergraduate fluid mechanics. Although we believe it is essential to have and to use a text when learning fluid mechanics, the choice of preferred texts is somewhat personal. We have selected three good and widely-used texts for recommendation to you. Any one of these texts or an earlier edition will be valuable as you begin to learn about the exciting and widely applicable area of fluid mechanics.

F.M. White, Fluid Mechanics, 7th Ed., McGraw-Hill, 2010 (ISBN 978-0077422414).

- A thorough and generally rigorous undergraduate text. The mathematical approach makes it an excellent reference to hold onto and to use throughout your studies and beyond. A standard text in engineering schools throughout the world. However, some students find it difficult at first as an introductory text.

C.T. Crowe, D.F. Elger, and J.A. Roberson, Engineering Fluid Mechanics, 9th Ed., John Wiley & Sons, 2008 (ISBN 978-0470259771).

- An introductory text aimed at both 2<sup>nd</sup> and 3<sup>rd</sup> 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 White as a long term reference, it might be better as a first introduction to fluid mechanics.

R.W. Fox, A.T. McDonald, and P.J. Pritchard, Introduction to Fluid Mechanics, 7th Ed., John Wiley & Sons, 2008 (ISBN 978-0471742996).

- Another widely used introductory text. The content is similar to that of White, and there is an emphasis on problem solving in the text.

### Grading

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

One Mid-term test:	20%
Final examination:	65%
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.**

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 an overall passing grade for the reports will result in a grade of FND (failure no deferred) for the course.**

### **Midterm Exam:**

Due to the lack of availability of suitable rooms during the term, there will be no traditional mid-term exam. Instead, there will be a 24-hour take-home test assignment. This assignment will be posted to **CULearn at 16:45 on Wednesday Feb. 12, 2013.**

### Laboratory Experiments

All students will be required to perform three laboratory experiments, as described in the course manual. The experiments will be conducted near the middle of the term. The precise scheduling of the laboratory sessions will be announced in lectures. 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 personally submit their laboratory reports to the drop box outside the Mechanical and Aerospace Engineering Office (3135 Mackenzie Bldg.) or to the Teaching Assistant (TA) responsible for that lab, one week 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 the cover sheet. 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.

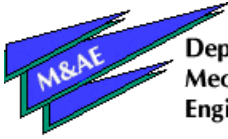
### **Problem Analysis Sessions with TAs**

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 outlined 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 them all. To assist you as much as possible, weekly Problem Analysis Sessions with the TAs have been arranged to help you as you work through these problem. All students are expected to attend the Problem Analysis Sessions. Selected example problems will also be solved in detail.

### **Lab Experiments / Problem Analysis Sessions with TAs:**

Section L01: Monday	11:35 – 14:25	Mackenzie Bldg.	Room 4342
Section L02: Thursday	11:35 – 14:25	Mackenzie Bldg.	Room 3165
Section L03: Tuesday	8:35 – 11:25	Southam Hall	Room 318
Section L04: Thursday	8:35 – 11:25	Mackenzie Bldg.	Room 4342
Section L05: Monday	8:35 – 11:25	Mackenzie Bldg.	Room 3328
Section L06: Wednesday	11:35 – 14:25	Mackenzie Bldg.	Room 4342
Section L07: Tuesday	11:35 – 14:25	Mackenzie Bldg.	Room 4342
Section L08: Friday	8:35 – 11:25	Mackenzie Bldg.	Room 4342
Section L09: Wednesday	8:35 – 11:25	Canal Bldg.	Room 3101
Section L10: Monday	14:35 – 17:25	Mackenzie Bldg.	Room 4342
Section L11: Thursday	14:35 – 17:25	Mackenzie Bldg.	Room 4332
Section L12: Tuesday	14:35 – 17:25	Mackenzie Bldg.	Room 4332
Section L13: Friday	11:35 – 14:25	Mackenzie Bldg.	Room 4342

***Please note:*** All laboratory work will take place in Mackenzie Building as outlined in the course manual. Laboratory group sign-up and schedule will be posted on CULearn after the first class have occurred. Because of equipment access and space restrictions, you can only sign-up for 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.



### Brief Outline of Lectures

Week	Relevant Book Section (White, 6 <sup>th</sup> ed.)	Topic
1	1.1-1.9	<b>Introduction.</b> Applications of fluid mechanics. Definitions: fluid, continuum concept, no-slip condition. Fluid properties. Units and dimensions.
2	2.1-2.4,	Pressure and shear stress. Pressure distribution in a fluid in a gravitational field. Examples.
3	2.9, 2.10	The atmosphere. Pressure measurement: mercury barometer, manometers. Effect of acceleration on the pressure distribution in a fluid: examples.
4	1.11, 3.1-3.3	<b>Fluid dynamics.</b> Streamlines and streamtubes. Steady flow. One-dimensional flow. Control volume approach. Continuity equation.
5	3.4	Linear momentum equation for a control volume.
6	3.4	Application of linear momentum to steady flows.
7	3.6, 3.7	Euler and Bernoulli equations. Bernoulli equation as an energy equation. Dynamic and total pressure. Applications of Bernoulli: measurement of flow rate (bellmouth inlet, venturi, orifice meter).
8	3.5	Angular momentum equation for a control volume. Application to steady flows.
9	3.6, 6.1-6.4	Steady-flow energy equation (SFEE). Effects of friction: losses. Concept of hydraulic head. Pump or turbine power; efficiency.
10	6.6-6.9	Viscous flow: laminar versus turbulent flow. Pipe flow analysis: Moody chart. "Minor" losses. Flow over immersed bodies: boundary layers, separation, drag.
11	2.5	<b>Fluid statics.</b> Forces on plane submerged surfaces. Centre of pressure. Examples. Forces on curved submerged surfaces.
12	2.6-2.8	Stresses in pipes and vessels due to internal pressure. Forces on submerged bodies: buoyancy. Stability of submerged and floating bodies: centre of buoyancy, metacentre.
13		Review

### Accommodations

You may need special arrangements to meet your academic obligations during the term because of disability, pregnancy or religious obligations. Please review the course outline promptly and 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.

Students with disabilities requiring academic accommodations in this course must register with the Paul Menton Centre for Students with Disabilities for a formal evaluation of disability-related needs. Registered PMC students are required to contact the Centre, 613-520-6608, every term to ensure that I receive your Letter of Accommodation, no later than two weeks before the first assignment is due or the first in-class test/midterm requiring accommodations. If you require accommodation for your formally scheduled exam(s) in this course, please submit your request for accommodation to PMC by November 7, 2008 for December examinations, and March 6, 2009 for April examinations.

You can visit the Equity Services website to view the policies and to obtain more detailed information on academic accommodation at <http://carleton.ca/equity/accommodation>