ME 303: Fluid Dynamics

Instructor: Prof. James Bird
Email: jbird@bu.edu
Office Hours: Thurs. 1:30-2:30 PM in EMA 202E

GST: Liangwei Zheng (zhenglw@bu.edu)

Course Grader: Maosheng Wu

Course schedule:
Lectures: MW 10:10 -11:55 AM Location: SAR 103 [635 Comm Ave]

Discussions: F 11:15 - 12:05 PM in CDS 264 [B1]
or F 12:20 - 1:10 PM in CDS 264 [B2]

Labs: Week of Mar. 17th & Apr. 21st [subject to change]
ENG 113 T 3:30-5:15 PM [C1]
or Th 1:30-3:15 PM [C2]

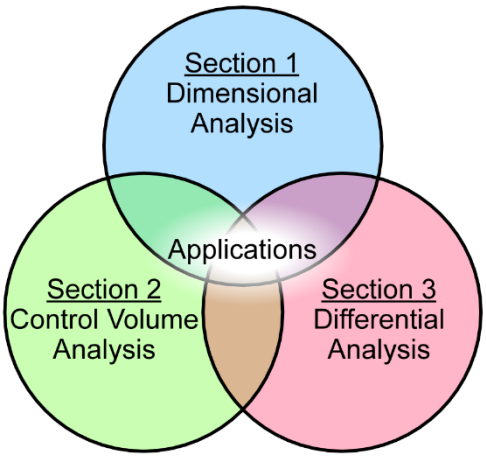
Course learning objectives: This course is designed to teach fundamental concepts of fluid dynamics through a broad range of applications. By the end of the course, the goal is for students to be able to:

1) Set up, simplify, and solve problems with **Dimensional Analysis** (scaling relations developed from the dimensions of the parameters and solutions through dynamic similitude).

2) Set up, simplify, and solve problems with **Control Volume Analysis** (constitutive equations and conservation laws in integral form).

3) Set up, simplify, and solve problems with **Differential Analysis** (constitutive equations and conservation laws in partial differential form).

4) Identify **applications** of these problem-solving approaches in disciplines including aerospace, mechanical, and biomedical engineering. Develop the skill to identify which analysis method is most appropriate for a given problem and justifying assumptions.



Prerequisites: MA 226 (Diff Eq) & EK 301 (Eng Mech) or equivalent.

Textbook: *Fundamentals of Fluid Dynamics* by Munson, Young, & Okisshi 6th, 7th, or 8th Edition (Instructor will use 8th Edition as reference).

Grading:
Lab reports (10%): Two (2) laboratory exercises.
Tests (45%): Three (3) in-class tests.
Final Exam (25%): Timed exam administered online during finals week.
Homework/Discussion Question (15%): Homework is assigned roughly every week and evaluated during quick quizzes in Discussion Section.
Participation (5%): Based on responses to questions and live lecture polls.
Link to lecture polls: https://forms.gle/xTUtQaZM5cbAtDch7

Diversity and Inclusion: We consider our classrooms to be a place where you will be treated with respect, and we welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability – and other visible and nonvisible differences. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class. If something was said in class, discussion, or office hours that made you feel uncomfortable, please let me know, or a trusted person (e.g. academic advisor) that can relay your concerns to me anonymously. Our goal is to provide everyone with the best learning experience possible.

Religious accommodations: We are aware of and in agreement with Boston University's Policy on Religious Observance, whereby absences for any religious beliefs are understood and missed assignments on such occasions will be given a chance to be made up. We require advanced notification at least a week for such occasions.

Blackboard: Used for class announcements, information, assignments, review material, additional notes, discussion forums, and schedule. **NOTE** that while grade assignments will be posted for your review, we do NOT use the Blackboard Gradecenter to calculate semester grades. Ignore any interpretation of your grade based on whatever Blackboard-reported "points" that are displayed.

Course Communication: Questions about homework problem sets, labs, and test review topics should be brought up in office hours, discussions, during appropriate lecture times, or posted to the appropriate discussion board on Blackboard (we will be using **Pronto**). To ensure fair access of information to all students, questions concerning any course material sent to the instructor via email will be posted to the discussion board.

Reading Assignments: Course lectures and pre-recordings coincide with the textbook for each topic as listed on the Course Schedule (last page here). Students are expected to familiarize themselves with the assigned pre-lecture readings/recordings before coming to class to fully engage in classroom discussions.

Discussions: Discussions are led by the GST. During discussions, the GST will review class topics, have a Discussion Quiz based on homework, and address students' questions.

Homework: Nine (9) homework assignments (problem sets) will be posted on gradescope at least one week before their due dates.

- Late homeworks will be accepted for grading up to **one day** late with a 10-point late penalty.

Tests/Final Exam: There are three (3) tests during the semester and one (1) final exam during finals period, as listed in the schedule. The Final Exam is cumulative.

- Missing a test/exam due to vacation is not excusable. Arrangements will be made on a case-by-case basis for documented emergencies or University conflicts (**7 days prior arrangement**).
- Students requiring additional time to complete examinations must supply proper documentation from the Office of Disability Services **at least 7 days in advance** of an exam.

Lab: There will be two (2) labs for this course. The first lab is experimental and will be performed during the scheduled Lab time. The second lab is theoretical and is performed by students using COMSOL a state-of-the-art computational fluid dynamic solver that can be accessed through BU Citrix. The lab is designed to be completed during the scheduled Lab time, but can be completed outside this time if necessary. Detailed instructions for the two labs are provided in separate documents. Some information and requirements below:

- Lab reports are limited to **5 pages in length**. Pages beyond the page limit will not be graded.
- Late labs will be accepted for grading up to **one week** late with a 10-point late penalty provided that the student is in correspondence with Prof. Bird before the original due date.

Policy on collaboration: Collaboration is encouraged on homework and labs. However, students must turn in their own work in their own words. No collaboration is permitted on tests/exams.

Boston University Academic Conduct Code:
Honesty is a core value of Boston University. Any violations of BU academic honesty and integrity standards will be pursued through appropriate University channels. This includes, but is not limited to cheating, plagiarism and misrepresentation. Academic misconduct is conduct by which a student misrepresents his or her academic accomplishments, or impedes other students' opportunities of being judged fairly for their academic work, which includes any help from online tutoring services during quizzes and exams. Knowingly allowing others to represent your work as their own is as serious an offense as submitting another's work as your own. If you have any questions as to what constitutes an honor code violation, please ask. ***Ignorance is not an excuse for cheating***. BU's Academic Conduct Code: http://www.bu.edu/academics/policies/academic-conduct-code/

Incompletes:
Incompletes will be permitted only for extenuating circumstances and must be arranged Prof. Bird as soon as such a circumstance arises. This situation only pertains to assignments whose due dates have not yet passed.

#	Date	Day	Topic	Textbook Reading	Pre-lecture recording	Due Dates*, exams
1	1/22/2025	Wednesday	Overview of Fluid Properties	Chap. 1		
2	1/27/2025	Monday	Pressure	2.1-2.6	Pressure gradients	
3	1/29/2025	Wednesday	Dimensional Analysis	7.1-7.6		Homework #1
4	2/3/2025	Monday	Modeling and Similitude	7.7-7.10		
5	2/5/2025	Wednesday	Dimensional Analysis of Internal Flows	8.4.1		Homework #2
6	2/10/2025	Monday	Dimensional Analysis of External Flows	9.1, 9.3		
7	2/12/2025	Wednesday	Introduction to Control Volumes	4.3-4.4		Homework #3
Test	2/18/2025	TUESDAY	**Test 1 on Lectures 1-6**			**Test #1**
8	2/19/2025	Wednesday	Conservation of Mass	5.1		
9	2/24/2025	Monday	Conservation of Energy	5.3		
10	2/26/2025	Wednesday	Problem Solving with the Bernoulli Equation	3.6		Homework #4
11	3/3/2025	Monday	Conservation of Momentum	5.2		Lab #1 – Data (By Friday)
12	3/5/2025	Wednesday	Buoyancy and Hydrostatic Forces	2.8-2.12		Homework #5
SPRING BREAK (Mar. 8 – 16)						
13	3/17/2025	Monday	Problem Solving with Control Volumes			
14	3/19/2025	Wednesday	Open channel flow	10.1-10.3 10.6		Homework #6
Test	3/24/2025	Monday	**Test 2 on Lectures 7-13**			**Test #2**
15	3/26/2025	Wednesday	Kinematics I	4.1		Lab #1 – Report (Due Friday)
16	3/31/2025	Monday	Kinematics II	4.2; 6.1		
17	4/2/2025	Wednesday	Conservation of Mass & Navier-Stokes Equations	6.2 – 6.8		Homework #7
18	4/7/2025	Monday	Unidirectional flow	6.9; 8.2		Lab #2 – Data (By Friday)
19	4/9/2025	Wednesday	Inviscid (Potential) Flows	6.4-6.7		Homework #8
20	4/14/2025	Monday	Problem Review & Applications	Ch. 6		
21	4/16/2025	Wednesday	**Test 3 on Lectures 14-20**			**Test #3**
	4/21/2025	Monday	NO CLASS			
Test	4/23/2025	Wednesday	Boundary Layers on Flat Plate	9.1 – 9.2	Veritasium video	Lab #2 – Report
22	4/28/2025	Monday	Boundary Layers on Curved Surfaces & Turbulence	8.3, 9.2, 9.4	Blasius Solution	
23	4/30/2025	Wednesday	Review			Homework #9
	TBD		Final Exam [cumulative]			

* Assignments are due online by the end of the day