# ME 303: Fluid Dynamics

**Instructor:** Prof. James Bird
Email: jbird@bu.edu
Office Hours: Thursday 12PM (noon) through zoom, meeting ID on blackboard

**GST:** Alex Levy (levyalex@bu.edu)

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

**Course schedule:**
Lectures: MW 10:10 -11:55 AM Location: PHO 211 (max of 19 students in-class)
Lectures are live-streamed and recorded on Zoom (meeting ID on blackboard)
Discussions: Friday 12:20 - 1:10 PM in EMB 125
Discussion sessions also live-streamed on Zoom, meeting ID on blackboard.

**Resources**:

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

**Lab Materials**: Note that there are no lab kits for this course. Students will use sensors on their phone via an app such as phyphox as well as COMSOL software via BU Citrix.

**Expectations Regarding Safety:** Masks are required to be worn over mouth and nose at all times when attending lectures or discussions on campus in-person, as well as when in University buildings before and after those in-person session. A minimum of 6 feet distance should be kept between everyone whenever possible. Students, instructor, and GST are required to follow all University guidelines with respect to daily symptom checks, testing, social distancing, and mask wearing when they leave their dorm or home and inside University buildings.

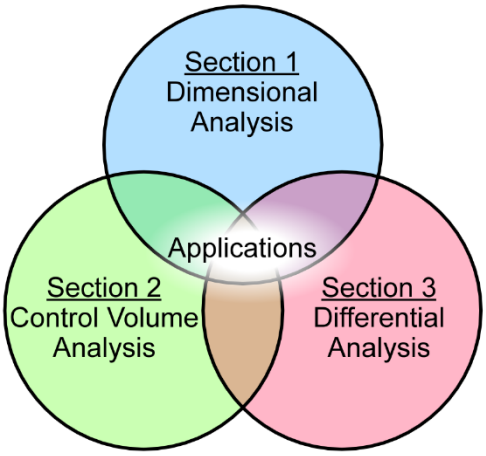
**Diversity and Inclusion:** We consider our classrooms to be a place where you will be treated with respect, and we welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability – 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, zoom IDs and schedule. Blackboard is also used for quizzes and exams unless otherwise communicated by the instructor or GST throughout the semester. **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.

**Zoom:** Used for all lectures, discussions, and office hours. Zoom is also required for students attending in-person lectures (phone app sufficient when in classroom). Make sure to equip your computer and/or phone with the zoom app and link your BU account to it. **Passcode: ME303**

**Course Communication:** Questions about homework problem sets, labs, and exam/quiz 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.




**Course learning objectives:** This course is designed to teach fundamental concepts of fluid dynamics through a broad range of applications. In particular, we will cover:

1) Dimensional analysis: the ability to explore a problem based upon the dimensions of the parameters. While this cannot provide exact answers, it is extremely useful for determining scaling relationships and identifying factors that can be ignored.

2) Control volume analysis: solving constitutive equations and conservation laws in integral form to understand the behavior of fluids.

3) Differential analysis: directly solving governing equations such as the Navier-Stokes equations as a means of understanding fluid behavior.

4) Applications of these problem solving approaches in disciplines including aerospace, mechanical, and biomedical engineering. A critical skill to be acquired is the ability to identify which analysis method is most appropriate for a given problem and justifying assumptions.

**Grading:**
Homework (10%): Nine (9) problem sets assigned roughly every week.
Lab reports (20%): Two (2) laboratory exercises.
Exams (36%): Three (3) "in-class" timed exams administered online.
Final Exam (24%): Timed exam administered online during finals week.
Participation (10%): Based on responses to pre-lecture and live lecture polls.

**Pre-lecture recordings:** Recordings of mathematical and conceptual derivations will be posted as a narrated video at least 1 day ahead of many lectures (indicated in schedule). Students are expected to watch the recording BEFORE the lecture and familiarize themselves with the content, which includes the use of the textbook. Recordings contain embedded questions to gain feedback on the "muddy" parts that need to be further addressed in class. Pre-lecture recordings make up 1/3 of the participation grade: 50% for answering the questions, 50% for accuracy. Recordings are posted to the lecture folders on blackboard. Note: The schedule and topics of pre-recordings are subject to adjustment throughout the semester, and the schedule will be consistently updated on blackboard.

**Lectures:** The scheduled lectures will focus on the conceptual aspects of the topics to build an intuitive understanding of the subject matter, and the application of the concept in engineering and problem solving. Students have the option to attend the class online or in the classroom until

capacity is reached. Only students who signed up through the InClassLfA app are allowed to come to the classroom. All lectures are live streamed on zoom for all students to attend and participate, and recorded. The stream will mostly consist of the instructor's shared electronic whiteboard and slides that the lecture material is presented on, as well as audio of the instructor. Recordings and lecture notes will be made available to all students on blackboard, but are not a substitute for attending the lectures.

**Lecture participation:** Throughout the lectures, interactive polls will be used to review the topics and concepts and to gain feedback of the students' understanding of the material. The polls are multiple choice/answer-type questions. The participation in these polls is required for all students, in-class AND remote. For in-class students, using Zoom on a phone is sufficient to participate in the polls. Participation in the polls make up 2/3 of the participation grade. The instructor reserves the right to change the grading scheme of participation, for example to include accuracy of answers to some degree towards the grade, with prior notification to the students and not retroactively.

**Reading Assignments:** Course lectures and pre-recordings coincide with the textbook for each topic as listed on the Course Schedule. Students are expected to familiarize themselves with material before coming to class to fully engage in classroom discussions and to revisit the learned material after class by practicing associated problems.

**Discussions:** Discussions are led by the GST. During discussions, the GST will address students' questions, review class topics, and solve practice problems. All discussions are live-streamed on zoom for all students to attend and participate, and can be attended in-person by registering with the InClassLfA app. Recordings and selected discussion notes will be made available to all students on blackboard, but are not a substitute for attending the discussions live. Students are encouraged to submit questions to the GST before the discussions to ensure the best possible preparation.

**Homework:** Nine (9) homework assignments (problem sets) will be posted on gradescope at least one week before their due dates. Homework are due on Mondays (end of day) in the weeks indicated on the course schedule. Homework submitted on Tuesday are subject to a 10% penalty. Later homework will not be accepted. Students must upload their *handwritten* solutions to gradescope: either photos of the handwritten solutions on paper or a pdf file of the solutions handwritten on a tablet or touchpad/screen. For each problem you should clearly show all work (given, asked for, properties, assumptions, equations, math, answer). Individual homework problems are graded on a 100/80/50/0 scale.

**Exams:** There are three (3) exams during the semester and one (1) final exam during finals period, as listed in the schedule. Each exam will take place on blackboard, the semester exams during regularly scheduled class time (pending further information). The Final Exam is cumulative by nature.

- Missing an 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 is performed by students at their own time and place. Students need access to: a sink faucet, ziplock bag, and a smart phone with a pressure sensor (phyphox app can be used collect data). 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. If there are concerns about equipment access, please alert the instructor and/or GST as soon as possible.

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.
- Collaboration for the labs is strongly encouraged, e.g. through video calls between students to address experimental issues, discuss possible solutions, and work out data analysis.

**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 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/

**Drop and Withdrawal Dates:**
The last day to DROP (with no 'W' on your record): March 1st
The last day to WITHDRAW (with a 'W' on your record): April 2nd

**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.