ME 303 A1: FLUID MECHANICS FALL 2023

Boston University College of Engineering

Instructor:	Prof. Keith A. Brown
Office	8 St. Mary's Street (Photonics), Rm 920
Email	brownka@bu.edu
Phone	617-353-4841
Office Hours	M 3:00 to 4:00 in PHO 920 – or by appointment
Lecture:	MW 10:10-11:55 AM in EPC 207
Discussion:	R 11:15-12:05 PM in EPC 208 F 11:15-12:05 PM in STH 113
Teaching Assistants:	Rebecca Shannon (rebshan@bu.edu) *Discussions & homework help* Eli Forstadt (eforstad@bu.edu) *Labs*

Course Materials and Resources:

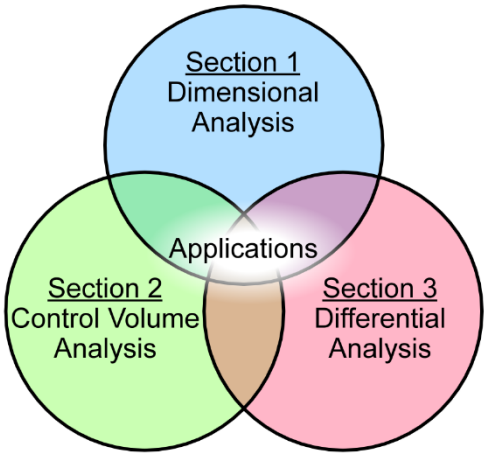
Textbook:	"Fundamentals of Fluid Mechanics" by Munson et al., Wiley 8th edition *Companion to material presented in class and example problems*
Blackboard:	http://learn.bu.edu *Assignments, announcements, lecture slides, and your grades*
Gradescope:	https://www.gradescope.com/ *Submission of assignments*
Piazza:	https://piazza.com/ *Forum for open discussion between students and instructors*
Prerequisites:	ENG EK 301 or equivalent CAS MA 226 or equivalent

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 (25%):	2-3 problem sets per module
Lab reports (20%):	Three laboratory exercises (Lab 1 worth 4%, Labs 2 & 3 each worth 8%)
Exams (45%):	Three closed-book exams; formula sheets will be provided
Analysis challenges (6%):	Results of analysis challenges, three in total
Participation (4%):	Based upon overall participation in class

Once grades have been posted for two weeks, regrades will no longer be accepted.

Homework:
One of the best methods to learn the material is to read the text before the material is presented in class, attend and pay attention in class, and work through the assigned problem sets. The course is structured to give you ample feedback regarding your understanding of the material. Assistance and worked examples will be provided in discussion and the homework review sections, so please seek out help as you need it!

Another helpful practice is to alternate teaching the problems to your classmates, which will force you to think about how to tackle and solve a problem. It is common for engineers to work in groups, so keeping in mind the Ethics Code, we encourage you to form groups to work out (but not copy) the problem sets. The exams are solo efforts, however, so it is in your best interest to make sure you understand the problem sets and not rely too heavily on your classmates or the GST.

Problem sets are due Monday at 11:59 PM via Gradescope. Typed solutions or clearly legible photographs of hand-written solution sets are acceptable. Late homework will not be accepted.

Lab exercises:
There will be three lab exercises for this course. To complete the labs that take place in the lab room (Labs 2 and 3), you must register for Block A which is held in ENG 113A during:
C1 – Monday, 8:00 to 9:45 AM
C2 – Tuesday, 3:30 to 5:15 PM
C3 – Wednesday, 4:30 to 6:15 PM
C4 – Friday 12:20 to 2:05 PM

- Turning in a report without physically completing the lab exercises will result a deduction of 25% of the total score for the assignment.
- Students may work in pairs while performing experiments and may prepare and submit reports in these pairs.
- Late reports WILL NOT be accepted without prior approval of Prof. Brown. Note that GST is not permitted to grant extensions and all such requests must go through Prof. Brown.
- Submission of labs is through gradescope and it is the responsibility of the student to make sure that lab files can be opened and read without issue.

Exams:
Each exam will take place over an entire class period. There will be three exams during the semester, each covering one module in a non-cumulative manner.

- 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.
- 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 examination to the instructor so suitable arrangements can be made.
- ***Exams:*** There will be three in class examinations. They will take up the entire class period.
  Exam 1: Covering Lectures 1-7 Monday 10/2

Exam 2: Covering Lectures 8-15	Wednesday 11/1
Exam 3: Covering Lectures 16-25	Matrix exam time during finals week

Make-up exams will be given only in extreme circumstances. It is your responsibility to let your instructor know as far in advance as possible of an unavoidable conflict or medical emergency.

DO NOT MAKE TRAVEL PLANS FOR THESE DATES.

Discussion Sections: Discussion sessions are optional and will focus on Q&A related to homework and worked examples beyond those in lecture.

Homework help sections: There will be homework help sections before the deadline of every problem set. These are staffed by the GST who will be available to answer questions about the problem sets. The date and time of these will be determined through student poll.

Policy on collaboration: Collaboration is encouraged on homework and labs, however students should turn in their own work in their own words. No collaboration is permitted on exams.

Classroom Courtesy: To preserve an open and distraction-free learning environment for all students, the following policies apply:

- Cell phone use is not permitted in class. This includes calls, texting, web browsing, games, etc.
- Students disrupting class or distracting their classmates will be asked to leave the classroom.

Boston University Academic Conduct Code*:* Honesty is a core value of Boston University. Any violations of the BU academic honesty and integrity standards ***will be pursued*** through appropriate University channels. This includes, but is not limited to: cheating, plagiarism and misrepresentation. If you have any questions as to what constitutes an honor code violation, please ask. ***Ignorance is not an excuse for cheating***. You may access the BU Academic Conduct Code at:
http://www.bu.edu/academics/policies/academic-conduct-code/

Course Schedule:

The following is a tentative schedule for the course

	Date	Topic	Assignments	Reading
Dimensional Analysis	W 9/6	Lec1: Overview of fluid properties & pressure	PS1 out	1
	M 9/11	Lec2: Hydrostatic pressure & measuring pressure		2.1-6
	W 9/13	Lec3: Buoyancy and hydrostatic Forces	Lab 1 out	2.8-12
	M 9/18	Lec4: Dimensional analysis	PS1 due, PS2 out	7.1-6
	W 9/20	Lec5: DA of internal vs external flows		8.4.1, 9.1,3
	M 9/25	Lec6: Modeling and similitude	PS 2 due, PS3 out	7.0-7
	W 9/27	Lec7: Review and analysis challenge 1	Lab 1 due	
	M 10/2	**EXAM 1: DIMENSIONAL ANALYSIS**	PS3 due	
Control Volume Analysis	W 10/4	Lec8: Introduction to control volumes		4.3-4
	T 10/10	Lec9: Conservation of mass	PS4 out,	5.1
	W 10/11	Lec10: Conservation of energy		5.3
	M 10/16	Lec11: Problem solving with the Bernoulli equations	PS4 due, PS5 out	3.6
	W 10/18	Lec12: Conservation of momentum	**Lab 2**	5.2
	M 10/23	Lec13: Advanced control volume problems	PS5 due, PS6 out	
	W 10/25	Lec14: Review		
	M 10/30	Lec15: Analysis Challenge 2	Lab 2 & PS6 due	
	W 11/1	**EXAM 2: CONTROL VOLUME ANALYSIS**		
Differential Analysis	M 11/6	Lec16: Acceleration and the material derivative	PS7 out	4.1
	W 11/8	Lec17: Kinematics		4.2; 6.1
	M 11/13	Lec18: Continuity and the Navier-Stokes equations	PS7 due, PS8 out	6.2
	W 11/15	Lec19: Unidirectional flow	**Lab 3**	6.3,8
	M 11/20	Lec20: Two dimensional flow and the stream function		6.9; 8.2
	M 11/27	Lec21: Inviscid flows	PS8 due, PS9 out	6.4-5
	W 11/29	Lec22: Lift and the Magnus effect		6.6-7; 9.4
	M 12/4	Lec23: Boundary layers and D'Alembert's paradox	PS9 due	9.2
	W 12/6	Lec24: Turbulence		8.3
	M 12/11	Lec25: Review and analysis challenge 3	Lab 3 due	
	Finals	**EXAM 3: DIFFERENTIAL ANALYSIS**		