Fluid Mechanics CE122L

Fall 2011

Duke University
Department of Civil and Environmental Engineering

Instructors

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Meeting Times and Locations

Lectures:	MWF 11:55-12:45, Hudson Hall, Room 115A
Laboratory / Help Session -	Th 2:50-4:05, or 4:25-5:40, Hudson Hall, Room 201
Additional Help Session	AS NEEDED: please request them 2 days in advance

References

- Necessary package (ISBN 9780470103852):
  - Munson, Young, and Okiishi, *Fundamentals of Fluid Mechanics*, John Wiley & Sons, New York, 6th edition, 2009.
  - **Wiley Plus**, an on-line system that includes an electronic version of the textbook along with on-line homework problems and on-line tests.

  The ISBN number for the textbook and **Wiley Plus** is 9780470437308.
- Optional but Helpful:
  - Munson, Young, and Okiishi, Student Solutions Manual and Study Guide, ISBN 9780471718963
  - We may also use assigned articles or chapters from books and scholarly journals.

Note # 1:

Although the necessary textbook package can be purchased in parts, it is likely more economical to purchase it as a whole–Wiley offers us 10% discount through our textbook store. In fact, even buying used books (without Wiley Plus) and separately purchasing Wiley Plus ($80 or so) is most likely to be more expensive than getting the whole new package!

Note # 2:

If you do not need to have a printed textbook, you may consider purchasing just Wiley Plus ($80 or so) directly from the publisher at www.wileyplus.com. However, please keep in mind that if you decide to go with this option, you will lose access to this electronic resource after the semester ends. Again,**Wiley Plus** is **necessary** for the course!

Exams and Grading

All exams are open book but closed notes.
NOTE: if you take notes in your book, your book is considered a notebook.

Tests:	Three Midterms	see the schedule below
	Final Examination	Wednesday, December 14 9:00-noon
Grading	3 Midterms (15% each) (tentatively scheduled below)	45%
	Final	20%
	Homework	20%
	Lab Reports	10%
	Quizzes (8 best out of 13)	5%

"A+" Challenge

Ace the final exam and earn an A+ no matter what your performance in the course! (Don't count on it too much, as it was claimed only six times in 14 years of my teaching at Duke).

Assignments

- Reading assignments are given with the class schedule in this handout and will be elaborated on as we progress through the semester. **Please read the material before we cover it in class.**
- Homework assignments will be handed out on Monday and will be due the following Monday. They consist of 8 mandatory problems, 1 extra-credit problems, and 3 optional problems. Homework assignments will be accepted until their solutions are posted on the course website on the following Wednesday at 5:00pm.
- Each homework assignments has at least one computational problem (marked with a star). *Credit for problems of this type can be earned only by developing and using a computer program.* Any computer language (C, C+, Fortran, Basic, etc.) or computational environment (Mathematica, Matlab, etc.) is acceptable. Submit the printout of your code, input, and output with the assignment.

  - Solutions to all mandatory and extra-credit problems will be posted on our blackboard website (http://courses.duke.edu).
  - Unless excused by the Dean's Office, late homework will carry a penalty of 5% per each late day.
  - You are encouraged to solve the homework problems on their own rather than in groups – learn the subject from your own mistakes carefully studying the posted solutions.
  - **Up to 1/8 of the points lost on homework assignments can be made up through the extra-credit problems.**

- Five to seven *physical* labs will be conducted approximately biweekly during the semester.
- One mandatory field trip that counts as laboratory will be scheduled for late October. The date will be posted on blackboard website during the first few weeks of class.
- Lab reports in the format discussed in a separate document class are required for each lab experiment and are due on Thursday, the week after the experiment is performed. Late lab reports carry a penalty of 5% per each late day.
- Some lab demonstrations will also be presented at the end of the lectures.
- One unannounced quiz will be offered each week.

Tentative Class Schedule

Week	Lecture #	Topics	Reading
1	8/29, 8/31, 9/2	Introduction	Chapter 1
2	9/5, 9/7, 9/9	Fluid properties, units	Chapter 1
		Hydrostatics, pressure, buoyancy	Chapter 2
3	9/12, 9/14, 9/16	Fluid kinematics: Eulerian and Lagrangian descriptions, continuum assumptions, streamlines, flow fields, steady and transient flow,	Chapter 3
4	9/19, 9/21, 9/23	Bernoulli's equation Mathematical review: multivariate calculus, differential operators, divergence theorem, localization theorem	
5	9/26, 9/28, 9/30	Systems and control volumes Reynolds transport theorem	Chapter 3, 4
6	10/3, 10/5, 10/7	**MIDTERM I**, Continuity equation	Chapter 5
		Fall Break	
7	10/12, 10/14	Incompressible ideal fluids, Balance of momentum	Chapter 5
8	10/17, 10/19, 10/21	Conservation of energy	Chapter 5
9	10/24, 10/26, 10/28	**MIDTERM II**, Differential approach laminar and turbulent flows, boundary layers, Navier-Stokes equations	Chapter 6
10	10/31, 11/2, 11/4	Dimensional analysis, the Pi theorem, similitude	Chapter 7
11	11/7, 11/9, 11/11	Pipe Flow	Chapter 8
12	11/14, 11/16, 11/18	**MIDTERM III**; Pipe Flow	Chapter 8
13	11/21	Open channel flow	Chapter 10
		Thanksgiving Break	
14	11/28, 11/30, 12/2	Open channel flow	Chapter 10
15	12/5, 12/7, 12/9	Advanced topics and/or review	
16	Wednesday, Dec. 14 9:00-noon	**FINAL EXAMINATION**	all inclusive

Course Outcomes

Upon completion of the course

1. students will **understand the basic concepts** of fluid mechanics for compressible and incompressible fluids, including
    - fluid statics and
    - fluid dynamics,
2. students will **understand the basic perspectives** of fluid mechanics, including
    - finite control volume analysis,
    - differential analysis,
    - dimensional analysis, similitude, and modeling,
3. students will be able to **think critically**,
4. students will **develop skills** in the following areas:
    - choosing appropriate concepts and perspectives to describe and formulate problems involving fluid mechanics,
    - solving problems involving invicid and viscous flow in pipes, ducts, and open channels,
    - designing, conducting and interpreting laboratory experiments involving fluid mechanics, including evaluating errors via sensitivity analysis,
    - writing reports on conducted experiments and solutions to problems posed in homework assignments.

Learning Objectives

1. Understand the basic concepts of fluid mechanics for compressible and incompressible fluids, including fluid statics and fluid dynamics.
2. Understand the basic perspectives of fluid mechanics, including finite control volume analysis, differential analysis, dimensional analysis, similitude, and modeling.
3. Utilize theory learned in the classroom toward engagement in laboratory experiments that evaluate applied principles in fluid statics and dynamics.
4. Develop and test hypotheses that will guide experimental approaches taken in the laboratories.
5. Think critically about solution procedures for problems related to fluid mechanics, evaluation of these solutions, and interpretation of lab or modeled data.
6. Communicate via written technical reports incorporating charts and other graphics and summarize findings and recommendations in oral presentations appropriate for clients, decision-makers, and the general public.

Measurable Outcomes

1. Learn the basic concepts of fluid mechanics for compressible and incompressible fluids, including fluid statics and fluid dynamics.
2. Learn the basic perspectives of fluid mechanics, including
   (a) finite control volume analysis,
   (b) differential analysis,
   (c) dimensional analysis, similitude, and
   (d) modeling.
3. Learn to apply theory learned in the classroom toward engagement in laboratory experiments that evaluating applied principles in fluid statics and dynamics.
4. Learn to develop and test hypotheses that will guide experimental approaches taken in the laboratories
5. Learn to think critically about solution procedures for problems related to fluid mechanics, evaluation of these solutions, and interpretation of lab or modeled data
6. Learn to communicate via written technical reports incorporating maps, charts, and other graphics, and summarize findings and recommendations in oral presentations appropriate for clients, decision-makers, and the general public.

The problem sets and quizzes focus solely on evaluating the learned problem solving skills, while the reports on laboratory experiments focus on developing skills in designing and conducting experiments as well as writing concise reports. The four exams (three midterms and one final) test not only the problem solving skills, but also the depth of understanding of basic principles– they consist of two parts: problem solving (open-book, closed-notes) and derivations (closed-book, closed-notes).

This course provides foundation to CE123L Water Resources Engineering, CE124L Environmental Engineering, CE193 Integrated Environmental Design, and a number of graduate classes.

Important University Policies

- **The Duke Community Standard:**
  - Duke University is a community of scholars and learners, committed to the principles of honesty, trustworthiness, fairness, and respect for others. Students share with faculty and staff the responsibility for promoting a climate of integrity. As citizens of this community, students are expected to adhere to these fundamental values at all times, in both their academic and non-academic endeavors.
  - The Pledge
    Students affirm their commitment to uphold the values of the Duke University community by signing a pledge that states:

1. I will not lie, cheat, or steal in my academic endeavors, nor will I accept the actions of those who do.
2. I will conduct myself responsibly and honorably in all my activities as a Duke student.

– The Reaffirmation
Upon completion of each academic assignment, students will be expected to reaffirm the above commitment by signing this statement: *I have adhered to the Duke Community Standard in completing this assignment.* Note that this statement will be required for all work submitted for a grade in this course.

– Further Information Available from:

Honor Council	www.duke.edu/web/honorcouncil
The Kenan Institute for Ethics	www.kenan.ethics.duke.edu
Undergraduate Judicial Board	www.studentaffairs.duke.edu/conduct/resources/ujb
Undergraduate Conduct Board	www.studentaffairs.duke.edu/conduct/about/ucbhearings

- **Short-Term Illness:**

  – The course policy for making up a graded exercise missed due to a short-term illness will be consistent with the university policy, spelld out at

  www.pratt.duke.edu/policies-procedures

  – Notable features of this policy are that you need to inform me as soon as you become aware of an illness that will prevent you from completing an assignment, and that you are responsible for making arrangements with me to make up the work as soon as is possible after the missed exercise.

Duke University Bulletin Description

Physical properties of fluids; fluid-flow concepts and basic equations; continuity, energy, and momentum principles; dimensional analysis and dynamic similitude; viscous effects; applications emphasizing real fluids. Selected laboratory work. Co-requisite: Engineering 123L.