Course Syllabus

Course Information - Spring 2013

MECH 3315.001
INTRODUCTION TO FLUID MECHANICS
Room: GR 3.420
Time: MW 4:00-5:15
Final: TBA

Professor Contact Information

Prof. Wonjae Choi
Office: RL 4.704
Phone: 6625
Email: wonjae.choi@utdallas.edu
Office Hours:
Walk in at regular office hours (TBA)
Or by appointment (please use email to set this up)

Course Pre-requisites, Co-requisites, and/or Other Restrictions

Prerequisites: ENGR 3300 (Advanced engineering mathematics). Corequisites: ENGR 2300 (Linear algebra), MECH 3310 (Thermodynamics)

Course Description

MECH 3315 Introduction to Fluid Mechanics (*3 semester hours*)

In this course we will study the behavior of fluids at an introductory level. One of the most important differences between solids and fluids is the fact that, as long as a finite stress is applied on a fluid, the fluid indefinitely continues to deform. Few problems in fluid mechanics discipline, therefore, deal with equilibrium. The other unique feature of a fluid is the fact that a fluid at a macroscopic level can be considered as a continuum, that is, all properties associated with a fluid changes gradually over the space. Such unique features of fluid mechanics often cause confusion or even frustration to students who take fluid mechanics course for the first time. We will, therefore, begin the course by familiarizing ourselves with the core concepts of fluid mechanics, including the concept of continuum, velocity field and strain rate, viscosity and so forth. We will also briefly review the mathematical skills necessary for this course before we dive into real problems in fluid mechanics.

We will then study how to apply Newton's law (F=ma) to solve problems in fluid mechanics. At first we will cover simple cases such as fluid statics or the motion of an inviscid fluid, that is, a fluid without viscosity. Next we will consider the fluids with constant viscosity, also known as Newtonian Fluids. Viscosity of most real fluids is, of course, dependent on various factors including temperature, shear rate, pressure, and others. Nevertheless, fluids in numerous problems can be approximated to have constant viscosity, and we will spend nearly a half of the course to understand the physics governing the behavior of Newtonian Fluids. Specifically, we will solve internal flows (e.g., pipe flows), external flows (drag of a submarine), and flows with free surfaces (the flow of a river). After we work on Newtonian Fluids, it is a perfect time for us to have a look at dimensional analysis: very useful is an ability to qualitatively analyze complicated problems and understand what are the important variables of the given system are and why. Such an analysis, when correct, helps engineers to greatly reduce the time to perform more detailed, quantitative analysis. Dimensional analysis – ironically, this analysis is in large part about how to nondimensionalize the given problem – gives engineers an ability to systematically perform such a qualitative analysis for a wide range of fluid mechanics problems.

Student Learning Objectives/Outcomes

This course promises that, assuming you will fulfill your responsibility (e.g., attend most classes, be attentive, read the assigned materials and complete homework on time), you should be able to achieve the following goals by the end of the semester:

- You will be able to understand why the Navier-Stokes equation governs the behavior of fluids, and why the equation is sometimes essentially impossible to solve. You will also understand when the equation can be simplified into practical forms such as Bernoulli equation, Stokes equation, and others; you will be able to apply these knowledge to solve a wide set of fluid mechanics problems.
- You will also develop your skills in applying non-dimensional analysis, and learn how to obtain a qualitative but quick evaluation on various fluidic systems.

Required Textbooks and Materials

1. Primary: Reading assignments and other homework will come from this book.
R.W. Fox & A.T. McDonald's Introduction to Fluid Mechanics 8th Edition (7^{th} edition is also okay to use), P.J. Pritchard, John Wiley, New York, 2009, ISBN 13: 978-0470547557

2. Secondary: My lecture note, which will be posted on eLearning

Assignments & Academic Calendar
(Topics, Reading Assignments, Due Dates, Exam Dates; numbers in parentheses are the chapters in Fox's book)

Week 1 Core concepts (1-2)
Week 2 Math review (4-5, only mathematics)
Week 3 Fluid statics (3)
Week 4 Control volume: integral approach (4)
Week 5 Fluid motion: differential approach (5), Midterm #1 (2/20)
Week 6 Review on W1 ~ W5, Inviscid flow (6)
Week 7 Inviscid flow (6)
Week 8 Newtonian flow – internal flow (8)
Week 9 Newtonian flow – internal flow (8)
Week 10 Newtonian flow – external flow (9)
Week 11 Newtonian flow – external flow (9), Midterm #2 (4/2)
Week 12 Review on W6 ~ W12, Newtonian flow – flow with free surfaces (11)
Week 13Dimensional analysis (7)
Week 14 Dimensional analysis (7)
Week 15 Advanced problems (12, 13, etc)
Week 16 Advanced problems (12, 13, etc), Final

Grading Policy

Pop Quiz	10%
Midterm 1 (Thru)	18%
Midterm 2 (Thru)	18%
Final (Comprehensive)	24%
Class Notes & Homework*	30%

** Notes and homework handed in late will not be accepted unless the student has informed the instructor in advance by at least two full days.*
** Notes and homework must be handed-in in class.*
** Plagiarism may be punished by failure of the assignment, exam, or the entire course.*
** Pop quizzes will also be used to check your attendance. There will be five quizzes and missing three or more quizzes will lead to a discount of your final grade (three: B →B-, four: B→C), and missing all of them will lead to the failure. There will be no penalty though, if you have a legitimate reason to miss a class and give the instructor a notice in advance.*

Course & Instructor Policies
(make-up exams, extra credit, late work, special assignments, class attendance, classroom citizenship, etc.)

Off-campus Instruction and Course Activities
Below is a description of any travel and/or risk-related activity associated with this course.

Policies and Procedures for Students
The University of Texas at Dallas provides a number of policies and procedures designed to provide students with a safe and supportive learning environment. Brief summaries of the policies and procedures are provided for you at http://provost.utdallas.edu/home/index.php/syllabus-policies-and-procedures-text and include information about technical support, field trip policies, off-campus activities, student conduct and discipline, academic integrity, copyright infringement, email use, withdrawal from class, student grievance procedures, incomplete grades, access to Disability Services, and religious holy days. You may also seek further information at these websites:

- http://www.utdallas.edu/BusinessAffairs/Travel_Risk_Activities.htm
- http://www.utdallas.edu/judicialaffairs/UTDJudicialAffairs-HOPV.html
- http://www.utsystem.edu/ogc/intellectualproperty/copypol2.htm
- http://www.utdallas.edu/disability/documentation/index.html

These descriptions and timelines are subject to change at the discretion of the Professor.