Phys 282/Pgeog 383.38 – Spring 2007
Introduction to Fluid Mechanics

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General Description – 3 credits

This course covers the basic principles of fluid mechanics at an introductory but detailed level. Topics include statics, forces on plane and curve surfaces, kinematics of fluid motion, integral and differential representation of conservation of mass, the first Law of Thermodynamics, Bernoulli's equation, dimensional analysis, and elementary viscous flow. Frictional losses, simple pipeline analysis and steady channel flow are covered. Understanding of the physical phenomena is stressed and vector notation is used whenever suitable.

The course will provide the foundations for a series of future courses that concerns fluids that students will encounter in physics an environmental studies interested in careers in many branches of applied physics and engineering (mechanical engineering, civil and environmental engineering, biomedical engineering, biophysics, atmospheric sciences, oceanography, earth and planetary sciences), such as Hydraulics, Hydrology, Groundwater Flow, Contaminant Transport, Heat Transfer, Aerodynamics, Hydrodynamics, Geophysical fluid Dynamics, Propulsion Systems, Chemical Reactor Design, Polymer Engineering and Chemical Process Dynamics.

Desired Course Outcomes:

- To make students view fluids based on physical laws.
- To enable students analyze fluids phenomena using physical laws and mathematics.
- To make students link real fluids with descriptive/analytical work.
- To stimulate students' interest in understanding the complex world of fluids.

Prerequisites
Calculus I and II. Students with one semester of Calculus may be able to take this course while they are taking the second semester of Calculus. Basic physics recommended or/and permission of instructor.

Textbook: "Fundamentals of Fluid Mechanics" by Munson, Young and Okiishi (Third Edition, Wiley Press).

Guideline for grades: 30% from two Midterm Exams, 25% from Homeworks, 10% from Class Participation and 35% from Final Exam.

Goals and Objectives

At the end of the semester, students would be expected to know the following:

- How to determine pressure in a static liquid; write manometer equations; calculate the magnitude and location of point forces due to fluid pressure on a plane surface.
- How to use the Bernoulli Equation to determine how changes in fluid velocity influence fluid pressure.
- How to use conservation of mass, energy and momentum with a control volume to analyze or design a flow system.
- How to use dimensional analysis to present experimental data;

List of Topics (following Textbook's Table of Contents)

1. Introduction
2. Fluid Statics
3. Elementary Fluid Dynamics — The Bernoulli Equation
4. Fluid Kinematics
5. Finite Control Volume Analysis
6. Differential Analysis of Fluid Flow
7. Similitude, Dimensional Analysis, and Modeling
8. Viscous Flow in Pipes

Tentative Syllabus

Week #/Date	**Topic/Chapter**	**Assignments**	**Notes**
Week 1 Jan 30 – Feb 2	Introduction: Overview of course structure, standards and expectations. Review of mathematical fundamentals. Overview of general physical properties of fluids	**HW# 1**: Problems from Chapter 1: 4, 5, 6, 7, 10, 12.	
Week 2 Feb 6 – Feb 9	Chapter 1: Fluid properties, viscosity, elasticity, surface tension, dimensions, units.	**HW# 2**: Problems from Chapter 1: 53, 54, 58, 69, 73, 76, 77, 82, 85, 86.	
Week 3 Feb 13 – Feb 16	Discussion of Problems from Chapter 1. Chapter 2: Fluid Statics: pressure, hydrostatic forces, buoyancy, pressure variations.	**HW# 3**: Problems from Chapter 2: 2, 3, 4, 5, 7, 12, 21, 22, 24, 26, 29, 32.	
Week 4 Feb 20 – Feb 23	Chapter 3: Elementary Fluid Dynamics - The Bernoulli Equation. Basic physics: Newton's laws.	**HW# 4**: Problems from Chapter 3: 1, 2, 3, 7, 8, 10, 13, 19, 29, 30, 31, 32, 36, 37, 38, 93, 94.	

Week #/Date	Topic/Chapter	Assignments	Notes
Week 5 Feb 27 – Mar 2	Chapter 3: The Bernoulli Equation. Basic physics: Newton's laws.		
Week 6 Mar 6 – Mar 9	Chapter 3: Review of Bernoulli's equation and application ***Midterm Exam I***		
Week 7 Mar 13 – Mar 16	Chapter 4: Kinematics description of fluid flow.	**HW# 5**: Problems from Chapter 4: 1, 2, 3, 4, 5, 6, 7, 10, 15, 23, 24, 35, 39, 43, 60.	
Week 8 Mar 20 – Mar 23	Chapter 4: More fluid kinematics, Reynolds Transport Theorem, continuity equation.		
Week 9 Mar 27 – Mar 30	Chapter 5: Finite control volume analysis	**HW# 6**: Problems from Chapter 5:	
No Class April 3 – April 6	**Spring Break**		
Week 10 April 13	Chapter 5: Finite control volume analysis		
Week 11 April 17 – April 20	Chapter 6: Conservation of mass, continuity, linear momentum, energy and Bernoulli's equation ***Midterm Exam II***	**HW# 7**: Problems from Chapter 6:	
Week 12 April 24 – April 27	Chapter 6: Differential analysis of fluid flow.		
Week 13 May 1 – May 4	Chapter 6: Differential analysis of fluid flow.		
Week 14 May 8 – May 11	Chapter 7 - Dimensional analysis and application to modeling.	**HW# 8**: Problems from Chapter 7:	
Week 15 May 15	**Overall Review**	**HW# 9**: Problems for general review:	
Tuesday, May 22	**Date of Final Exam**		

<u>IF TIME PERMITS</u>, we will discuss Chapter 8.2: Basic application of viscous flow dynamics to pipes.