ME 5700/6700 Syllabus
Fluid Dynamical Phenomena
Fall 2007

Lecturer: Eric R. Pardyjak

Lecture: 12:55 pm – 1:45 pm (120 WEB)

Office Hours: 2 pm - 4 pm M W 160 Kenn B

Text: *Fluid Mechanics* by P.K. Kundu and I. M. Cohen, 3rd Edition, Elsevier Academic Press, 2004. Handouts and problems will be provided in class and on the web.

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Prerequisites: ME3700 or equivalent undergraduate fluid mechanics course.

Course Description:
This 3 credit hour course is an intermediate fluid dynamics course designed to be a bridge between undergraduate fluid mechanics (ME 3700) and advanced graduate level fluid dynamic (ME 7700). This class will introduce students to a variety of higher level topics in classical fluid mechanics. The course will also include 3 laboratory sessions that will help to enforce course objectives detailed below.

Course objective: Demonstrate a mastery of skills that can be used to solve fluid dynamics problems involving physical and mathematical modeling. These skills will include: using the governing equations to determine important parameters necessary for hypothesis testing, setting up, running and analyzing a computational fluid dynamics simulation and utilizing mathematical fundamentals solve complex problems.

Course Outcome: Given a real-world fluid dynamics problem, students will be able to simplify the problem through an understanding of the fundamental equations of motion.

Course Topics Covered:

1. Governing Equations of Fluid Motion
    a. Review of important basic concepts (definition of a Fluid, Eulerian vs. Lagrangian, etc) – Kundu Chap. 1, Chap. 3
    b. Review of some important mathematical theorems (Stokes, Gauss, Leibniz, etc.) – Kundu Ch. 2
    c. Derivation of the differential form of conservation of mass, momentum and energy equations – Kundu Ch. 4, Currie Ch. 1 (handout)
    d. Simplification of equations (including developing the mechanical energy equation) and interpretation of various terms, Currie Ch. 1 (handout)
    e. Introduction to Cartesian tensors and index notation - Ch. 2.1- Kundu

2. Scaling and Scale Analysis
    a. Basic dimensional analysis concepts including Buckingham Pi. - Ch. 5 White (handout)
    b. Similitude - Ch. 5, White (handout)
    c. Scale Analysis - Ch.1, Bejan (handout)

3. Laminar Boundary Layers (Ch. 9, Fox & McDonald)
    a. Boundary Layer Equations
    b. Introduction to combination of variables - Blasius Solution
    c. Lab #1 – Laminar boundary Layer measurements (Error Analysis Handout)
    d. Generalized Boundary Layer Problems (Ch. 4 Bird, Stewart & Lightfoot)

4. Introduction to Vorticity Dynamics (Ch. 5 Kundu)
    a. Introduction basic vorticity concepts
    b. Derivation of the vorticity transport equation
    c. Kelvin's circulation theorem
    d. Law of Bitot and Savart

5. Introduction to Turbulence (Ch. 13 Kundu)
    a. Basic concepts, description and definitions
    b. Derivation of time averaged equations (Potter/Foss handout)
    c. Discussion of stresses and closure problem

6. Turbulent Boundary Layers (Ch. 13 Kundu)
    a. Introduction to turbulent boundary layers
    b. Lab #2 – Turbulent boundary layer hot-wire measurements
    c. Momentum balance in a turbulent boundary layer, pipe and channel flow (Wei et al. 2005 JFM paper).

Homework: Weekly homework assignments will be given during class and posted on the web site. Homework will be collected in class on the due date. Late homework will generally not be accepted.

Laboratory: There will be a total of two labs as part of the class. The first two labs are experimental and will meet in undergraduate fluid mechanics lab in building 60. If time permits, a third lab will be a computational fluid dynamics lab that will meet in the CADE lab.

Grading and Exams: The course grade will be composed of weekly assigned homework, three lab sessions, one midterm examinations and a final exam.

Homework: 35%
Laboratory: 10%
Midterm Exam 1 (October 24, 2007): 25%
Comprehensive Final: 30%

Cheating: You are allowed to cooperate on homework by sharing ideas and methods. Copying will not be tolerated. Submitted work copied from others will be considered academic misconduct and will be reported to the appropriate University of Utah entities.

Exemptions: The University of Utah conforms to all standards of the Americans with Disabilities Act. If you wish to qualify for exemptions under this act, notify the instructor and the Center for Disabled Students Services, 160 Union.