ME509 – Intermediate Fluid Mechanics

Fall 2014

Course Syllabus

Course Description

ME509 covers the principal concepts and methods of fluid dynamics. Topics include basic laws, the Navier-Stokes equation for viscous flows and some of the exact solution, dimensional analysis, vorticity dynamics, introduction to boundary layers and turbulence.

Learning Objectives

At the completion of this course, every student should be able to:

- Explain the basic concepts in fluid mechanics; describe the physics and formulate mathematical descriptions of viscous flows;
- Interpret Navier-Stokes equations and how to obtain the exact solutions of canonical problems;
- Apply dimensional analysis for model tests;
- Identify the fundamental concepts in vorticity dynamics, boundary layer theory, and turbulence;
- Formulate physical model and mathematic model to solve typical fluids problems of engineering importance.

Prerequisite

ME509 must be preceded by an undergraduate course in fluid mechanics or aerodynamics (ME309 or equivalent), advanced calculus, and differential equations.

Meeting Time

Mon/Wed/Fri 8:30-9:20am, HMPT 1252

Instructor

Prof. Jun Chen

Office: ME 2145 / CHAF 129

Phone: 765-494-7050 Email: junchen@purdue.edu

Office Hour: Mon/Wed/Fri 9:30-10:30am (ME 2145, or by appointment)

Teaching Assistant

Ms. Nina Zhou

Phone: 219-671-5855 Email: zhou9@purdue.edu

Office Hours: Wed/Fri 2:00-3:30pm (ME2166, except Sept. 17th and Dec.12th)

Textbook

- Panton, R. L., ***Incompressible Flow***, 3rd Edition, J. Wiley.

Reference Books*

- Pritchard, P. J., ***Fox and McDonald's Introduction to Fluid Mechanics***, 8th ed., John Wiley & Sons Inc., 2011
- Batchelor, G. K., ***An Introduction to Fluid Dynamics***, Cambridge University Press.
- Oertel, H., et al., ***Prandtl-Essentials of Fluid Mechanics***, 3rd ed., Springer. [§]
- Van Dyke, M., ***An Album of Fluid Motion***, Parabolic Press, Inc.

[§] Digital book is available through Purdue Library.

Class Blog

http://www.purdue.edu/mixable

This blog is designed to facilitate the discussion and information exchanges between students, teaching assistant, and instructor. All registered ME509 students can log into this blog using their Purdue career account username and password.

General Policy

- Attendance: class attendance is required.
- Homework: homework will be assigned periodically and the due date will be given in the assignment sheet.
- Exams: two mid-term exams and one final exam will be scheduled. All exams will be open book, open notes and taken in class (2.5 hours). *Up to two textbooks and one notebook are allowed for the exams.*
- Group discussion on course materials is permitted, but each student must finish homework and exams INDEPENDENTLY and NO TEAMWORK is allowed. Violations will subject to academic sanctions.

Fluid Mechanics Films

In 1970's, National Committee for Fluid Mechanics Films (NCFMF) released a series of films that revolutionized the teaching of fluid mechanics. These films illustrate different fluids phenomena and discuss the associated underlying principle. The films have been posted online by *MIT's iFluids program* (http://web.mit.edu/hml/ncfmf.html). Watching these films is an integral part of the homework assignment. The materials covered in the films will be included in exams.

Grade Policy

- Homework:(20%)
- Mid-term exams (25%+25%) and final exam (30%)
- Letter grade (+/-)

Emergency Plan

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant information about changes in this course will be disseminated by course email list and Purdue Blackboard system.

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Progress Schedule *

Week	Date	Topic
1	Aug 25, 27, 29	Introduction, Vector & Tensor Calculus
2	Sep 1 Sep 3, 5	*Labor Day* (*No Class*) Basics, Fluid Statics
3	Sep 8, 10, 12	Kinematics of Fluid Motion, Basic Laws
4	Sep 15, 17, 19	Basic Laws
5	Sep 22, 24, 26	Basic Laws, Inviscid Flow
6	Sep 29 Oct 1, 3	Dimensional Analysis and Modeling ***Exam 1*** *(No Class)* [Coverage of week 1-5] Dimensional Analysis and Modeling
7	Oct 6, 8, 10	Navier-Stokes Equations, Boundary Conditions
8	Oct 13 Oct 15, 17	***Fall Break*** *(No Class)* Exact Solutions of Navier-Stokes Equations
9	Oct 20, 22, 24	Low Reynolds Number Flows
10	Oct 27, 29, 31	Lubrication Theory
11	Nov 3 Nov 5 Nov 7	Lubrication Theory ***Exam 2*** *(No Class)* [Coverage of week 1-10] Irrotational Flows
12	Nov 10, 12, 14	Irrotational Flows, Vorticity Dynamics
13	Nov 17, 19, 21	Viscous Boundary Layer
14	Nov 24, 26 Nov 28	*APS-DFD Meeting (No Class)* *Thanksgiving Holiday (No Class)*
15	Dec 1, 3, 5	Instability and Transition
16	Dec 8, 10, 12	Introduction to Turbulence
17	Dec 15-20	***Final Exam*** *(TBA)* [Coverage of week 1-16]

* Subject to change.