JOINT INSTITUTE
交大密西根学院

Course Syllabus

Degree Program:

□ECE-Electrical & Computer Engineering
■ME -Mechanical Engineering
□General Courses for Both ECE & ME Degree Programs

Course Name: Fluid Mechanics (VM320)
Term offered: Summer 2016-2017 (3 credits)
Course Category: ■ Required □ Elective

Instructor(s): (Email, office hours and office room No. should be included)
Lipo Wang, lipo.wang@sjtu.edu.cn Room 209
Office hours: working time

Textbook: Fluid mechanics, 4th edition, by P. K. Kundu, I. M. Cohen and D.R. Dowling, Academic Press, 5th edition
References:
1. Modern compressible flow, John D. Anderson, Mcgraw-Hill company, 1982
2. Fluid mechanics, Landau, Lifschitz

Course Pre/Co-requisites:
Mathematic courses: calculus, vector analysis
Mechanics courses: theoretical mechanics, thermodynamics

Grading Policy:
- ~15% from homework
- ~35% from one midterm exam & ~45% from one final exam
- ~5% from overall performance
- Relative grading

Course description and scheduled teaching contents

1. Introduction of fluid mechanics; unit system, solids and fluids, continuum hypothesis; transport phenomena and shear stress; surface tension; fluid statics; thermodynamics

2 (Bases of vector analysis) Space and coordinate; rotation of axes; second-order tensor and tensor contraction; Kronecker Delta and alternating symbol; dot and cross product; divergence and gradient operators; symmetric and antisymmetric tensors; Eigenvalues and eigenvectors of a symmetric tensor or a symmetric matrix; Multi-variables functions; Force on a surface; Gauss and Stokes' theorems;

3 (Kinematics): Eulerian and Lagrangian descriptions; Streamline, path line streak line; Strain rate; Vorticity and circulation; Relative motion near a point; Strain rate and angular velocity; Galilean transformation; Solid body motion and irrotational vortex; Reynolds transport theorem, including the 1D Leibnitz theorem,

4 (Conservation laws) Conservation of mass; Momentum conservation; constitutive equation for Newtonian fluids; Navier-Stokes equation; Application of the Reynolds transport theorem; rotating coordinate system; mechanical energy equation; Bernoulli equation; Boussinesq approximation; Boundary conditions; applications of the Reynolds transport theorem; dynamic similarity (for systems with deterministic governing equations & systems without explicit governing equations); common nondimensional parameters.

5 (Laminar flows) steady flow between parallel plates; steady flow in a pipe; rotating flows; impulsive started plate; flow due to an oscillating plate; elementary lubrication theory; creeping flow around a spherical surface.

6 (Boundary layers and related topics) basic idea; different measures of boundary layer thickness; boundary layer on a flat plate; structure of boundary layers; Von Karman momentum integral; boundary layer with pressure gradient; flow past a cylinder, sphere and the applications; secondary flows, 2D jets

7 (optional) compressibility; speed of sound; basic relations for 1D flow; area-velocity relations; normal shock wave; some basic concepts for turbulence (averaged equations; energy cascade; rough surface)

Course objectives

1. Understand the basic physical concepts
2. Understand the required theories and analysis methods for typical fluid mechanics problems

3. From some important application examples to learn how to extract the essential physics from complex phenomena.

Academic Integrity: (Any types of honor code regulations like class rules, homework policy, exam rules or project collaboration policy could be defined here) It is very necessary to show up in the class. Homework assignments need to finish independently and submit on time. Frequent discussions and exchanges with the instructor are strongly encouraged. Any honor code violation behavior must be recorded with the corresponding penalty.