### ME561 Advanced Fluid Mechanics

Fall 2021

**Description:**

This course covers essential advanced topics in fluid mechanics as an introductory graduate level course surveying fundamental concepts, and methods used in fluid mechanics. Emphasis will be on patterns of incompressible viscous flows, potential flow, boundary layers, and some solutions of the Navier-Stokes equation. The course will conclude with introduction to hydrodynamic stability, transitory flows and turbulence.

Special emphasis will be given to numerical solutions of realistic problems in homework assignments.

**Tentative Schedule**

**Week 1-2.** Properties of fluids, surface tension, continuum hypothesis in mechanics, fluid statics

**Week 3-6.** Conservation of mass, energy and momentum, the Navier-Stokes equation

**Week 7-8.** Fluid Kinematics

**Week 8-9.** Streamlines, potential flow

**Week 10-11.** Laminar flows

**Week 11-12.** Boundary Layer separation, Drag and Lift

**Week 13-14.**  Introduction to stability and transition and turbulence

**Recommended Readings:**

*Viscous Fluid Flow*, F.M. White, McGraw-Hill

*Fluid Mechanics,* P.K. Kundu and I.M. Cohen, Elsevier.

**Grading:**

Two midterm exams: 30% each

Homework/projects: 30%

In-class quizzes: 10%

**Course Learning Outcomes:**

Upon completion of the course successfully, students will be able to

1. Use the concepts of surface tension, viscosity and shear to calculate fluid forces;
2. Explain the concept of manometers and apply the ideal gas law and hydrostatic equation to determine pressures;
3. Select an appropriate control volume to solve a fluid mechanics problem.
4. Use conservation of mass to calculate flow velocity in confinements;
5. Use conservation of momentum to calculate forces on fluids and objects interacting with them;
6. Use conservation of energy to calculate friction losses, pumping power and power output in fluidic systems;
7. Apply the concepts of stream function and velocity potential
8. Analyze certain types of flows using the Navier-Stokes equations.
9. Develop and use dimensionless variables for a given flow problem.
10. Apply appropriate equations and principles to analyze a variety of pipe flow arrangements.
11. Calculate boundary layer parameters for flow past a flat plate.
12. Calculate the lift and drag forces for various objects using lift and drag coefficients