ME561 Advanced Fluid Mechanics

Fall 2020

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. Properties of fluids, continuum hypothesis in mechanics
Week 2. Kinematics of fluid motion
Week 3. Conservation of mass, energy and momentum, the Navier-Stokes equation
Week 4. Incompressible flows
Week 5. Some solutions of the NS equation
Week 6. Streamlines, potential flow
Week 7. Vorticity dynamics
Week 8. Moderate Re number flows, asymptotic methods
Week 9. Kinematic decomposition of flow fields
Week 10. Ideal flows in a plane
Week 11. Boundary Layer separation, Drag and Lift
Week 12. Axisymmetric flows
Week 13. Introduction to stability and transition
Week 14. Introduction to 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%