Course: CE 31800 – Fluid Mechanics

Cross-listed Course: ME 31800 – Fluid Mechanics

Type of Course: Required for CE program

Catalog Description: Continuum hypothesis, velocity field, fluid statics, basic conservation laws for systems and control volumes, dimensional analysis and similitude, Euler and Bernoulli equations, Navier-Stokes equations, viscous flows, boundary-layer flow in channels and around submerged bodies, applications.

Credits: 3

Contact Hours: 3

Prerequisite Courses: ME 20000, ME 25100, and MA 36300

Corequisite Courses: None

Prerequisites by Topics: Thermodynamics I, Dynamics, Differential Equations


Course Objectives: To give the student 1) a foundation in the fundamentals of fluid mechanics; 2) practice in the analytical formulation of fluid mechanics problems using Newton’s Laws of motion and thermodynamics; 3) an introduction to experimental methods; and 4) an exposure to practical applications, work on a small design project, and the writing of a technical report related to the design project.

Course Outcomes: Students who successfully complete this course will have demonstrated an ability to:

1. Know the definitions of fundamental concepts of fluid mechanics including: continuum, velocity field; viscosity, surface tension and pressure (absolute and gage); flow visualization using timelines, pathlines, streaklines, and streamlines; flow regimes: laminar, turbulent and transitional flows; compressibility and incompressibility; viscous and inviscid.
2. Apply the basic equation of fluid statics to determine forces on planar and curved surfaces that are submerged in a static fluid; to manometers; to the determination of buoyancy and stability; and to fluids in rigid-body motion. (1)
3. Use of conservation laws in integral form and apply them to determine forces and moments on surfaces of various shapes and simple machines. (1)
4. Use of conservation laws in differential forms and apply them to determine velocities, pressures and acceleration in a moving fluid. Understand the kinematics of fluid particles, including the concepts of substantive derivatives, local and convective accelerations, vorticity and circulation. (1)
5. Use Euler’s and Bernoulli’s equations and the conservation of mass to determine velocities, pressures, and accelerations for incompressible and inviscid fluids. (1)
6. Understand the concepts of rotational vs. irrotational flows; stream functions, velocity potentials. Laplace equation and its relation to elementary plane flows of inviscid fluids: sinks, sources, vortex flows, and superposition of these flows. (1)
7. Understand the concepts of static, thermodynamic, stagnation, total, and dynamic pressures and how they are used in instrumentation. (1, 2, 4)
8. Apply principles of dimensional analysis and similitude to simple problems and use dimensionless parameters. (1, 2, 4)
9. Determine flow rates, pressure changes, minor and major head losses for viscous flows through pipes, ducts, simple networks and the effects of pumps, fans, and blowers in such systems. (1)
10. Design simple pipe systems to deliver fluids under specified conditions. (1, 2)
11. Understand principles of flow measurements such as direct methods, flow-restriction methods, linear methods, traversing methods, open-channel flow meters. (1)
12. Understand the concepts of viscous boundary layers and the momentum integral and use them to determine integral thicknesses, wall shear stresses, and skin friction coefficients. (1)
13. Understand the mechanics of viscous flow about immersed boundaries, as it relates to flow separation, wakes, profile drag, drag coefficients and the determination of drag forces exerted on such bodies. (1, 2)
14. Apply principles of fluid mechanics to the operation, design, and selection of fluid machinery such as pumps, blowers, fans, compressors, and turbines. (1, 2, 7)
15. Understand the ethical issues associated with decision making. (4)

**Lecture Topics**

1. Fundamental concepts and overview
2. Fluid statics
3. Basic equations in integral form  
4. Basic equations in differential form  
5. Flow of an inviscid and incompressible fluid  
6. Dimensional analysis and similitude  
7. Internal flow of incompressible and viscous fluid  
8. External flow of incompressible and viscous fluids  
9. Applications: fluid machines and design project

**Computer Usage**  Medium

**Laboratory Experience**  Low

**Design Experience**  Medium

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