

BE 436, Fundamentals of Fluid Dynamics

Course Information, Spring 2009

Course Description

Introductory course emphasizing the application of the principles of conservation of mass, momentum, and energy to fluid systems. *Prerequisites:* CAS MA 226 and ENG EK 301. Lecture: 4 credits.

Text

Munson, Young, Okiishi, and Huebsch (2008) *Fundamentals of Fluid Dynamics*, Sixth Edition, John Wiley.

Instructor

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Office hours: Tue, Fri 3:00–4:00 pm, or by appointment

Grading

- Homework assignments (10%) – *Assigned weekly and due at the beginning of class on Monday*
- Exam 1 (25%), week of March 1 (tentative)
- Exam 2 (25%), week of April 5 (tentative)
- Cumulative final exam (40%)

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Course Syllabus, Spring 2009

- Fluid statics
 - The hydrostatic equation (§§2.1–2.5)
 - Manometry (§2.6)
 - Pressure distributions in fluids undergoing rigid body motion (§2.12)
- The Bernoulli equation (§§3.1–3.6)
- Integral relations for a control volume
 - Reynolds transport theorem (§4.3–4.4)
 - Conservation of mass (§5.1)
 - Conservation of linear momentum (§5.2)
 - Conservation of energy (§5.3)
- Fluid kinematics
 - Lagrangian and Eulerian reference frames (§4.1)
 - The material derivative (§4.2)
 - Vorticity (§6.1)
- Differential relations for a fluid particle
 - Continuity equation (conservation of mass) (§6.2)
 - Conservation of linear momentum (differential form) (§6.3)
 - Constitutive relation for a Newtonian fluid (§6.8.1)
 - The Navier-Stokes equations (§6.8.2)
- Examples of incompressible viscous flows
 - Non-dimensionalization of equations of motion (§6.2)
 - Couette flow (§6.2)
 - Start-up transient for Couette flow (§6.2)
 - Poiseuille flow (2D and axisymmetric) (§6.2)
 - Oscillatory flow in a channel and a tube
- Dimensional analysis
 - Buckingham pi theorem (§§7.1–7.6)
 - Model similarity (§§7.8–7.9)
- Potential flow
 - Velocity potential and stream function (§§6.2.3, 6.4)
 - Two-dimensional plane flows (§6.5)
 - Superposition of plane flows (§6.6)
 - Laplace's equation
- External flow
 - Prandtl's boundary layer equations (§§9.1–9.2)
 - Blasius's solution for laminar flow over a flat plate (§9.2)
 - Displacement and momentum thicknesses (§9.2)
 - von Kármán's momentum-integral analysis (§9.2)
 - Lift and drag (§§9.3–9.4)
- Low Mach number compressible flow