**ME 30900**

**FLUID MECHANICS**

**Course Outcomes** [Related ME Program Outcomes in brackets]

1. Develop the ability to identify and classify the various *types of flows* one may encounter. [A1, A2]
2. Develop (from first principles) the *control volume formulation* of the basic laws with emphasis on conservation of mass and Newton’s 2nd law. [A1, A2, A3]
3. Apply the control volume formulation of the basic laws to *model physical systems*. [A2, A3, A4, A5]
4. Conduct *simple experiments* and analyze data [A3, A4, B1]
5. Enhance systematic *problem solving skills* and sharpen *written communication skills* through short technical laboratory reports. [A4, B2, B3]

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**Fundamental Concepts (2.0 wks)**

1. System, control volume (CV), basic laws for system
2. Pressure, density, manometry
3. Fluid statics, buoyancy
4. Flow visualization, Eulerian & Lagrangian descriptions
5. Stress, Newtonian fluid, viscosity

**Dimensional Analysis and Similitude (1.0 wks)**

1. Determining Dimensionless Groups
   - Buckingham Pi Theorem
   - Non-dimensionalizing basic differential equations
2. Flow Similarity and Model Studies

**Basic Equations (3.3wks)**

1. Relation of system derivatives to Control Volume formulation
2. Integral form for Control Volume (CV)
   - conservation of mass
   - momentum equation (inertial, differential and linearly accelerating CVs)
   - angular momentum, first law of thermodynamics
3. Differential Analysis of Fluid Motion
   - conservation of mass
   - acceleration of fluid element
   - Navier-Stokes equations

**Compressible Flow (3.0 wks)**

1. Review thermodynamics of an ideal gas
2. Speed of sound, Mach cone
3. Stagnation and sonic conditions
4. Isentropic flow: converging, converging-diverging nozzle
5. Stationary normal shocks
6. Flow in converging-diverging nozzles

**Incompressible Flow (5.7 wks)**

1. Inviscid
   - Euler’s equations in streamline system
   - Bernoulli equation
2. Viscous Flow
   - Internal
     - fully developed laminar flow
     - flow in pipes and ducts
     - fluid machinery, system performance
   - Flow Measurement
   - External
     - boundary layer
     - flow about immersed bodies
     - lift and drag

**Representative Laboratory Experiments**

1. Flow pattern study
2. Reynold’s experiment
3. Draining of a tank
4. Momentum study: Force on an elbow
5. Momentum study: Force of a jet on a flat plate
6. Wind tunnel air speed measurements
7. Radial flow between parallel disks
8. Velocity profile in pipe flow
9. Pipe friction
10. Boundary layer study
11. Pressure drag on a cylinder
12. Drag coefficient of a disk
13. Pump calibration
14. Compressible flow
1. COURSE NUMBER AND NAME: ME 30900 Fluid Mechanics

2. CREDITS AND CONTACT HOURS: 4 credits
   a. Lecture – 3 days per week at 50 minutes for 16 weeks
   b. Laboratory Prep – 1 day per week at 50 minutes for 16 weeks
   c. Laboratory – 1 day per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:
   C. Wassgren & S. Wereley

4. TEXTBOOK:

5. SPECIFIC COURSE INFORMATION:
   a. **Catalog Description:** Continuum, velocity field, fluid statics, manometers, basic conservation laws for systems and control volumes, dimensional analysis. Euler and Bernoulli equations, viscous flows, boundary layers, flow in channels and around submerged bodies, one-dimensional gas dynamics, turbomachinery. Typically offered in fall and spring.
   b. **Prerequisites:**
      ME 20000 – Thermodynamics I
      ME 26300 – Introduction to Mechanical Engineering Design, Innovation, and Entrepreneurship
      ME 27400 – Basic Mechanics II
      MA 26200 – Linear Algebra and Differential Equations
   c. **Status:** Required

6. SPECIFIC GOALS FOR THE COURSE
   a. Course Outcomes:
      [Related ME Program Outcomes in Brackets]
      1. Develop the ability to identify and classify the various types of flows one may encounter. [A1, A2]
      2. Develop (from first principles) the control volume formulation of the basic laws with emphasis on conservation of mass and Newton’s 2nd law. [A1, A2, A3]
      3. Apply the control formulation of the basic laws to model physical systems. [A2, A3, A4, A5]
      4. Conduct simple experiments and analyze data. [A3, A4, B1]
      5. Enhance systematic problem solving skills and sharpen written communication skills through short technical laboratory reports. [A4, B2, B3]
   b. Related ME Program Outcomes:
      [Related ABET Outcomes Listed in Brackets]
      A1. Engineering Fundamentals;   B3. Prof/Ethical Responsibility;
      A3. Experimental Skills;        B5. Life-Long Learning;
      A4. Modern Engr Tools;          C1. Leadership,
      A5. Design Skills;              C2. Global Engineering Skills;
      A6. Impact of Engr Solns;       C3. Innovation;
      B1. Communication Skills;       C4. Entrepreneurship
      B2. Teamwork Skills

7. LIST OF TOPICS: See following page.

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