Department of Mechanical Engineering

ME304– Fluid Mechanics

(Required)

Catalog Description: ME 304 (3-0-3)

Introduction to basic principles of conservation of mass, momentum, and energy as they apply to engineering systems which utilize fluids. Some of the topics studied are: dimensional analysis, theoretical and empirical analysis of one dimensional incompressible flows, empirical analysis of external and internal flows, and elementary boundary layer theory.

Prerequisites: Mech 236 – Dynamics
ME 311 – Thermodynamics I

Textbook(s) Materials Required:

1. Fundamentals of Fluid Mechanics 5th Ed., J. Wiley, 2006.

Course Supervisor: Dr. I. J. Rao

Pre-requisite by topic

1. Calculus
2. Ordinary differential equations
3. Force balance
4. Dynamics
5. First Law and property relations

Course Objectives[1]:

1. To develop the student's skills in applying the basic laws of mechanics to a static fluid. (A, B, C)
2. To develop student's skills in analyzing fluid flow through the application of the basic laws of mechanics to open systems. (A, B, C, E)
3. To develop the students skills in proper modeling by the application of the fundamental concepts of dimensional analysis and similitude. (A, B, C, E)
4. To provide the student with some knowledge and analysis skills associated internal duct flow.(A, B, C, D, E)
5. To provide the student with some knowledge and analysis skills associated with the concepts of boundary layers and flow separation. (A, B, C, D)

Topics[2] :

1. Definitions, fluid properties (3 hrs)
2. Fluid statics Pressure variation and its application in manometry and resultant forces on planer and curved surfaces. (3 hrs)
3. Flow patterns. Streamlines, pathlines, etc. Eulerian and Lagrangian descriptions. Fluid acceleration, local and convective. (3 hrs)
4. Control volume analysis:Application of continuity, momentum and energy equations. (6 hrs)
5. Differential analysis (3 hrs)

6. Euler's and Bernoulli's equations and application (3 hrs)
7. Dimensional analysis: Dimensionless parameters and model studies (3hrs)
8. Internal flows: Laminar and turbulent pipe flows (6 hrs)
9. Boundary layer concepts, laminar and turbulent flows (3 hrs)
10. Drag: Drag on two-dimensional bodies (3 hrs)

Evaluation Method:
1. Quizzes
2. Exam
3. Homework

Schedule: Lecture Recitation: 3 hours, per week

Professional Component: Engineering Science

Program Objectives Addressed: A, B, C, D, E

Course Outcomes[3] :

Objective 1

1.1 Students will demonstrate an ability to determine surface forces and pressure difference for a static fluid. (1,2,3) (a,e,h,k)

Objective 2

2.1. Students will demonstrate an ability to apply the conservation laws to a variety of physical problems and obtain engineering design quantities. (1,2,3) (a,c,e,h,k)

2. 2. Students will use software to solve some exercises (3) (a,c,e,h,k)

2. 3. Students will demonstrate the ability to property apply the mechanical energy equation to a variety of physical systems. (1,2,3) (a,c,e,h,k)

Objective 3

3. 1. Students will demonstrate an ability to form dimensionless groups and apply the resulting modeling laws to experimental data as well as a variety of engineering problems. (1,2,3) (a,e,h,k)

Objective 4

4.1. Students will demonstrate an ability to determine engineering design quantities (shear stress, losses, volumetric flow rates and pressures) for laminar and turbulent flows.(1,2,3) (a,c,e,h,k)

4.2. Students will demonstrate the use of engineering software for iteration type problems. (3)(a,c,e,h,k)

Objective 5

5.1 Students will demonstrate an ability to determine the drag characteristics and boundary layer parameters for laminar as well as turbulent flow. (1,2,3,4) (a,c,e,h,k)

5.2 Students will demonstrate an ability to determine the drag coefficient that is applicable to a variety of flow situations. (1,2,3,4) (a,c,e,h,k)

Prepared by: Rao **Date: September 25, 2006**

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[1] Capital Letters in parenthesis refer to the Program Objectives of the Mechanical Engineering

Department. Listed in Sec 2 d Tables B-2-9, B-2-12. Table B-2-8 links Program Objectives with the ABET a-k Criterion.

[2] Topic numbers in parenthesis refer to lecture hours. (three hours is equivalent to 1 week)

[3] Outcome numbers in parenthesis refer to evaluation methods used to assess the student performance. Lower case letters in parenthesis refer to ABET a-k outcomes.