MAE 101B
Advanced Fluid Mechanics

Designation: Required course for ME and AE

Catalog Data:
MAE 101B Advanced Fluid Mechanics (4)

Laminar and turbulent flow. Pipe flow including friction factor. Boundary layers, separation, drag and lift. Compressible flow including shock waves.

Prerequisites: Grades of C- or better in MAE 101A and MAE 110A.

Prerequisites by Topic: Integral and differential calculus, differential equations, Newton's laws, thermodynamics, basic concepts of fluid mechanics

Textbook and Required Materials: Frank White, Fluid Mechanics, Sixth Edition, Wiley, 2008.

Class/Laboratory Schedule: 4 lecture hours per week

Course Topics:
1. Laminar internal flow: Poiseuille and Couette flow
2. Turbulent internal flow
3. Internal flow with losses: major and minor losses, friction factor
4. Solution of pipe flow problems
5. Boundary layer thickness
6. Boundary layer for zero pressure gradient: Blasius solution and momentum integral
7. Drag and lift
8. Thermodynamics of compressible flow, stagnation enthalpy
9. Compressible flow with area changes
10. Compressible flow with heat loss: Rayleigh line
11. Compressible flow with friction: Fanno line
12. Shock waves

Course Objectives:
(Numbers in parenthesis refer to MAE Program Outcomes)

Objective 1: To teach students the basic principles underlying internal and external flow of viscous fluids and compressible flow (1a, AE12, ME 12).

Objective 2: To train students to identify, formulate and solve engineering problems concerning internal, external and compressible flows (1a, 5e, AE12).

Methods of Evaluation:
1. Homework will be regularly collected and graded.
2. Exams

Performance Criteria:
(Numbers in parentheses refer to the methods of evaluation used to assess student performance.)

Objective 1
1.1 Students will demonstrate an understanding of the physics underlying internal and external viscous flow (1, 2).
1.2 Students will demonstrate an understanding of the physics underlying compressible flow (1, 2).

Objective 2
2.1 Students will demonstrate the ability to identify the forces acting on a control volume in viscous flow and calculate velocity profiles and volume fluxes (1, 2).
2.2 Students will demonstrate an ability to solve problems related to flow in rough pipes, taking into account fittings and other minor losses (1, 2).
2.3 Students will demonstrate an ability to calculate properties of laminar and turbulent boundary layers (1, 2).
2.4 Students will demonstrate an ability to calculate the drag and lift forces on objects in external flows (1, 2).
2.5 Students will demonstrate an understanding of the physical laws underlying compressible flow (1, 2).
2.6 Students will demonstrate an ability to calculate generalized one-dimensional flow in the presence of heating, frictional forces and area changes, including normal shocks (1, 2).
2.7 Students will demonstrate that they can apply and combine the appropriate principles referred to in Objective 1 to the solution of problems (1,2).

Objective 3
3.1 Students will engage in consideration of engineering ethics and professional responsibility (1).

Contribution of Course to Professional Component:
Engineering Science

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Revised: S.G. Llewellyn Smith, April, 2008 via Teaching Work Group meeting.