MAE 104
Aerodynamics

Designation: Required course for AE

Catalog Data:
MAE 104 Aerodynamics (4)

Basic relations describing flow field around wings and bodies at subsonic and supersonic speeds. Thin-wing theory. Slender-body theory. Formulation of theories for the evaluation of forces and moments on airplane geometries. Application to the design of high-speed airplanes.

Prerequisites: Admission to the engineering major and grade C- or better in MAE 101A-B.

Prerequisites by Topic: Calculus, elementary physics, thermodynamics, and fluid mechanics.

Textbook and Required Materials: Anderson, J.D. Fundamentals of Aerodynamics. McGraw-Hill Series in Aeronautical and Aerospace Engineering.

Class/Laboratory Schedule: 4 lecture hours per week

Course Topics:

1. Fundamental principles: aerodynamic variables, aerodynamic forces and, flow similarities, conservation of mass, momentum and energy in fluid flow, vorticity and circulation. Kelvin circulation theorem.
2. Fundamental of inviscid incompressible flow: stream function and velocity potential. Governing equation for irrotational, incompressible flows. The Kutta-Joukowski theorem and the generation of lift.
3. Incompressible flows over airfoils: classical thin airfoil theory, symmetric airfoil, cambered airfoil. Lifting flow over arbitrary shape bodies, the vortex panel method.
4. Incompressible flows over finite span wings: downwash and induced drag, Prandtl?s classical lifting-line theory. Lifting-surface theory.
5. High speed aerodynamics: compressible flows, generation of shock waves and expansion waves. Supersonic flows over wedges and cones.
6. Supersonic flows through nozzles and diffusers
7. Subsonic compressible flows over airfoils: Linear theory
8. Linearized supersonic flows.
9. Numerical techniques for supersonic flows: methods of characteristics.

(Numbers in parenthesis refer to the MAE Program Outcomes)

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

Objective 1: To teach students the basic principles of classical aerodynamics. (1a,AE12)

Objective 2: To train students to apply principles of analysis to formulate and solve engineering problems in aerodynamics (1a,5e,AE12)

Objective 3: To encourage good problem solving skills and written analysis (5e,7g)

Objective 4: To introduce students to the design and performance evaluation of wings and other lifting surfaces. (1a,2b,3c,AE12)

Objective 5: To teach integration of theory and experimentation in the design of airplanes (1a,2b,3c,AE12)

Objective 6: To provide students with sound basis for subsequent courses in flight mechanics (1a,AE12,AE14).

Methods of Evaluation:

1. Weekly homework assignments.
2. Midterms and Final Exam.
3. Design project. Written report and oral presentation.

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

Objective 1
1.1 Students will demonstrate understanding of the basic principles of classical aerodynamics (1, 2, 3)

Objective 2
2.1 Student will demonstrate ability to apply principles of analysis to formulate and solve engineering problems in aerodynamics (3)

Objective 3
3.1 Student will demonstrate good problem solving skills and written analysis (1, 2, 3)

Objective 4
4.1 Student will demonstrate familiarity and understanding of the basic principles of the design of airplane components (1, 2, 3).
4.2 Students will demonstrate the ability to apply principles and perform analysis of complex systems (3)

Objective 5
5.1 Student will demonstrate the ability to integrate theory and experimentation in the design of airplanes (3)

Objective 6
6.1 Students will demonstrate understanding of the basic principles of aerodynamics (1, 2, 3)

Contribution of Course to Professional Component:
Engineering Science

Prepared by: J.C. Lasheras, September 2000.
Reviewed: F.A. Williams, March 2007.