AE 3021 High-Speed Aerodynamics (3-0-3)

Catalog Description: AE 3021 High-Speed Aerodynamics. Compressibility effects on airfoil and wing aerodynamics; supersonic potential flow; method of characteristics; boundary layer effects on aircraft performance.

Text: At the level of: John D. Anderson, Fundamentals of Aerodynamics, 4th Edition.

Educational Objectives: Introduce the students to the techniques for modeling compressible flows in the subsonic, transonic, supersonic, and hypersonic regime. Describe engineering approximations to turbulent flow over aerospace vehicles.

Expected Outcomes: Students will be able to: (a) account for compressibility effects, assuming that the incompressible aerodynamic characteristics of airfoils, wings or bodies of revolution are known; (b) estimate viscous drag characteristics of airfoils and wings in attached turbulent flow. (c) model 2-D supersonic flow including nozzle design.

Prerequisites: ~~Math 2403, CS 1321~~, AE 2020, AE 3450.

Lecture Topics:

1. Review (3 hours)
    a. Low speed aerodynamics
    b. Gas dynamics
    c. Conservation equations

2. Derivation of Compressible potential flow equation (3 hours)

3. Method of characteristics for supersonic flow. (6 hours)

4. Small-disturbance form of potential equation (3 hours)
    Linearized Potential Equation
    Linearized Pressure Coefficient
    Boundary Conditions
    Subsonic Similarity
    Airfoils in Supersonic Flow

5. Nonlinear techniques for supersonic flows (6 hours)
    Shock-expansion technique
    Busemann 2nd-order theory
    Sources of drag
    Drag Coefficient

6. Wings and Bodies in Compressible Flow (3 hours)

7. Transonic aerodynamics (3 hours)
   - Critical Mach Number
   - Airfoils in Transonic Flow
   - Supercritical airfoils
   - Transonic Drag Rise
   - Variation of Lift with M
   - Sweep
   - Supersonic and Subsonic Leading Edges
   - Transonic Area Rule

8. Review of boundary layer theory (3 hours)

9. Methods for predicting laminar boundary layer effects (3 hours)

10. Effects of compressibility in boundary layers (3 hours)

11. Transition to turbulence; physics of turbulence (2 hours)

12. Reynolds averaging and models for turbulent stresses (2 hours)

13. Empirical methods for computing turbulent boundary layers. (3 hours)

14. Tests (2 hours)

Revised by L. Sankar on May 23, 2007