AE 6030 Unsteady Aerodynamics

Catalog Description: AE 6030:Unsteady Aerodynamics 3-0-3 .

Unsteady potential theory for various speed ranges. Calculation of steady and unsteady aerodynamic loads on airfoils and wings. Vortex flows. Topics of current research interest.

Prerequisites: AE 3030 or equivalent.

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Text:

1. At the level of Katz and Plotkin, "Low-Speed Aerodynamics"
2. Supplementary Notes on Unsteady Airfoil Theory and Transonic Unsteady Aerodynamics.
3. AeroCD: CD and Web-based multimedia "helper" to review basic aerodynamics.
4. Matlab-based problem-solving assignments.

Prerequisites: AE 3030 or equivalent

Learning Objectives

1. Development of the potential theory approach for general flows and specialization to specific
1. speed regimes.
2. Modeling and calculation of unsteady effects on airfoil lift and pitching moment
3. General approach to modeling 3-D unsteady aerodynamics.
4. Simplified models for high and low aspect ration
5. Special features of transonic unsteady flows
6. Applications in modern unsteady aerodynamics

Lecture Topics: 1 week per topic, roughly.

1. Introduction to the course: Basic concepts and simple results in aerodynamics
2. The conservation equations of fluid dynamics: simplification to potential flow: velocity potential, acceleration potential, Kelvin's equation.
3. The full potential equation, and reduction to the linearized forms for supersonic, subsonic and incompressible /barotropic flows
4. Thin airfoil theory for incompressible flow
5. The problems of unsteady aerodynamics: overview. Unsteady flow over an airfoil
6. Solution tools: Biot-Savart Law, Carleman - Schwarz Inversion, Theodorsen function
7. Finite Wing theory for low-speeds, and specialization to
    a. Prandtl's lifting line theory
    b. Jones' slender wing theory
    c. Betz Cross flow theory
    d. Unsteady Vortex Lattice Method
8. Potential flow equation for different speed ranges, and simple solutions.
9. Supersonic unsteady flow
    a. Supersonic and subsonic leading and trailing edges

    b. Acoustic disturbances
    c. Mach Box method
    d. Slender body theory
10. Lectures on Transonic Unsteady Aerodynamics
11. Solutions for Prescribed Airfoil Motion and for Prescribed Freestream Fluctuations
12. Vortex Flow Aerodynamics
    a. Physical concepts
    b. Polhamus suction analogy
    c. Nonlinear Panel Methods
13. Additional Topics: Dynamic Stall, Moving-Wall Effects, Vortex Breakdown, Forebody asymmetry, Roll Response of Low-Aspect Ratio Wings, Wing-Rock.