Last modified: October 10, 2024

AE 6015 - Syllabus

Advanced Aerodynamics- 3 credits

General Information

Description

Introduce concepts, derivation, and application of aerodynamic fundamentals. Emphasis on advanced knowledge in analysis and design of fixed-wing, launch/atmospheric return vehicles, and rotating systems.

Pre- &/or Co-Requisites

Pre-requisites: At the level of AE 3030 with a minimum Grade of C or better.

Course Goals and Learning Outcomes

Goal: Develop advanced understanding of aerodynamic fundamentals in the incompressible, subsonic, transonic, supersonic, and hypersonic flow regimes, with emphasis on analytical methods for inviscid flows, that may be used to rapidly model and analyze 2-D and 3D configurations.

Learning Outcomes: Upon successful completion of this course, you should be able to

1. Understand and articulate the theory, physics, and basic methods of solving aerodynamic flows.
2. Apply this knowledge to existing and new aerospace vehicle configurations and estimate the surface pressure distribution, and aerodynamic forces and moments as a function of Mach number and vehicle orientation relative to the freestream.
3. Acquire an engineering perspective of advanced aerodynamic modeling tools through interactive learning activities.

Course Requirements & Grading

Description of Graded Components

Grading will be based on the following components:

- Assignments: 30%
- Midterm Exam: 35%
- Final Exam: 35%

Grading Scale

Your final grade will be assigned as a letter grade according to the following scale:

A	90-100%
B	80-89%
C	70-79%
D	60-69%
F	0-59%

Topics Covered

Part I: Incompressible Flow

- Governing Equations
- Irrotationality, vorticity, stream function, velocity potential, Laplace's equation, related theorems
- Superposition of solutions in 2-D and 3-D potential flow
- Review of 2-D Thin Airfoil theory (Undergraduate material)
- 2-D Thick airfoil modeling for Steady and Unsteady Flows
- High Lift system modeling in 2-D
- Review of Governing Equations for Viscous Flow and Boundary Layer Approximation (Undergraduate material)
- Empirical Methods for 2-D incompressible viscous flow over airfoils
- Slender body theory
- Review of 3-D Lifting Line Models for Finite Wings
- 3-D Vortex Lattice Methods for Lifting Surfaces FOR Steady and Unsteady Flow
- 3-D Panel Methods for Lifting Surfaces for Steady and Unsteady Flows
- 3-D Panel Methods for Complete Configurations

Part II: Subsonic and Transonic Flow

- Review of Governing Equations
- Review of 2-D Thin Airfoil theory
- Extension to Thick Airfoils
- 3-D Configurations in Subsonic Flow
- Review of Transonic Flow (Undergraduate Material)
- Variation of Lift and Drag in subsonic and Transonic Regime
- Origin of Wave Drag
- Techniques for Reduction of Wave Drag

Part III: Supersonic Flow

- Review of 2-D Thin Airfoil theory
- 3-D Steady Supersonic Flow over Thin Wings
- Bodies of Revolution
- Analytical Methods for Estimating Wave Drag
- Extension to Complete Aircraft

Part IV: Hypersonic Flow

- Hypersonic Shock and Expansion Relations
- Local Surface Inclination Methods
- Viscous Hypersonic Flow and Heat Transfer
- High Temperature Effects
- CFD Methods for Hypersonic Flows

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Course Materials

Textbook

Required: None.

Recommended: John D. Anderson, Fundamentals of Aerodynamics, Edition 5 or later.

Course notes

Lecture notes and required software will be posted on Canvas.