

AE 3030 – Aerodynamics Syllabus

Course Information

- **Hours:** 4-0-4
- **Semester:** Summer 2026
- **Section:** A (In-person, Atlanta main campus)
- **Instructor:** Sriram Parthasarathy Kalathoor
- **Classroom:** Guggenheim 442
- **Meeting Times:** Mondays & Wednesdays 3:30PM - 6:15PM
- **Office Hours:** By appointment (TBD)

Catalog Description

Aerodynamics of airfoils and wings in subsonic, transonic and supersonic flight. Laminar and turbulent boundary layers and effects of viscosity on aerodynamic performance.

Prerequisites

AE 2010 Thermodynamics and Fluids Fundamentals

MATH 2551 Multivariable Calculus

Course Objectives

Students will:

1. Learn how lift, drag and pitching moment are generated
2. Learn airfoil and wing geometric parameters and aerodynamic performance characteristics (C_p , C_L , C_M , C_D , drag polar)
3. Learn similarity parameters, physical characteristics and aerodynamic trends associated with continuum flow regimes (subsonic, transonic, supersonic, hypersonic; steady/unsteady; viscous/inviscid)

4. Learn how the potential flow approach can be used to predict incompressible and compressible aerodynamics
5. Learn the boundary-layer concept for modeling the effects of viscosity
6. Be introduced to non-continuum flows and non-Newtonian fluids
7. Be introduced to computational fluid dynamics (CFD)

Learning Outcomes

Students will be able to:

1. Use analytical methods to estimate lift and drag (including viscous effects) on airfoils, wings and bodies of revolution in subsonic and supersonic flight
 - Thin airfoil theory, finite wing theory, compressibility corrections, transonic effects, sweep effects, area rule
 - Supersonic linearized theory, shock-expansion method, Newtonian theory
 - Flat plate boundary layer results (laminar and turbulent)
2. Use numerical methods to calculate aerodynamic loads and moments (including viscous effects) on 2D and 3D bodies in incompressible and compressible flow
 - Panel methods and integral boundary layer methods
3. Describe physical characteristics (momentum and thermal) of laminar and turbulent boundary layers, including transition and separation

Required Materials

- **Mandatory textbook:** None
- **Recommended textbook:** Fundamentals of Aerodynamics, John D. Anderson (McGraw-Hill), 17th Edition
- **Class Notes:** Will be posted on Canvas on a weekly basis

Grading Policy

The following components count toward course grade:

- 3 in-class exams: 15% each
- 3 homework assignments: 10% each
- Term paper: 15% each
- Attendance & Participation: 10%

Extra credit opportunities may be provided through the course. The grade brackets for this course are as follows:

$$A \geq 87.5; \quad 87.5 > B \geq 75; \quad 75 > C \geq 50; \quad 50 > D \geq 40; \quad 40 > F$$

We might deviate from this grading scheme depending on class performance, but I will only curve in your favor.

Attendance & Participation

This course is offered in an in-person synchronous format. Since participation is a graded component of the course, students are encouraged to attend all the lectures. Participation will be assessed individually via either in-class questions, flash cards, before/after/in-class discussion, or office hours.

Criteria for Course Success

A successful student in this course will demonstrate regular attendance, informed participation and reasonable engagement with course content, have a mastery of fundamental concepts such as lift, drag, pitching moment, flow regimes, and other ideas covered in the course, as well as the capability to use mathematical methods (including calculus) to solve relevant aerodynamic problems.

Academic Integrity

The Georgia Tech Honor Code is central to the ideals of this course. Students are expected to be independently familiar with the Code and to recognize that their work in the course is to be their own original work that truthfully represents the time and effort applied. Violations of the Code are most serious and will be handled in a manner that fully represents the extent of the Code and that befits the seriousness of its violation. The Code can be found at <http://www.policylibrary.gatech.edu/student-affairs/code-conduct>

Etiquette

Students are expected to keep their mobile phones on vibrate/silent mode, and avoid doing non-course-related activities as a courtesy to their fellow students. Since classes are nearly 3 hours long, we'll have two breaks midway through every lecture. Students are expected to be on time for classes, communicate responsibly, and contribute to a positive learning environment for everyone.

Accommodations for Students with Disabilities

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services at (404) 894-2563 or dsinfo@gatech.edu, as soon as possible, to make an appointment to discuss your special needs and to obtain an accommodations letter. Please e-mail me as soon as possible in order to set up a time to discuss your learning needs.

Topical Outline

1) **Aerodynamics Introduction and Course Overview** (1 hour)

2) **Fluid Motion Basics** (1 hour)

- Streamlines, pathlines, steady vs. unsteady flow
- Rotation and vorticity
- Boundary layer concept

3) **Viscous Flow** (21 hours)

Incompressible Flow (16 hours):

- Solutions to the Navier–Stokes equations
- Boundary layer equations: exact solutions, Blasius solution, pressure gradient effects
- Physics of turbulence and its effects
- Turbulent flat plate solutions
- Transition mechanisms and prediction
- Momentum integral method, Thwaites method, Head’s method
- Squire–Young formula for drag
- Empirical transition estimation (Michel’s criteria)

Compressible Flow (5 hours):

- Compressibility corrections to boundary layer equations
- Skin friction and heat transfer prediction

4) **Potential Flow** (2 hours)

- Derivation of velocity potential equations for incompressible and compressible flows

5) **Low-Speed Aerodynamics** (15 hours)

- Elementary solutions: uniform flow, source/sink, doublet, vortex
- Flow around a cylinder, circulation, Kutta–Joukowski theorem
- Drag in separated flow, pressure coefficient distribution

Airfoils (6 hours):

- Thin airfoil theory
- Kutta condition
- C_L , C_M , lift curve slope
- Center of pressure and aerodynamic center
- Introduction to panel methods
- Numerical tools for skin-friction prediction

6) **Wings** (5 hours)

- Trailing vortices, vortex sheets, starting vortex
- Downwash and induced drag
- Aspect ratio effects
- Prandtl lifting-line theory
- Elliptic lift distribution, span efficiency factor
- Drag polars including viscous effects
- Vortex-dominated flows and leading-edge vortices

7) **High-Speed Aerodynamics** (15 hours)

Linearized Potential Flow Equation (1 hour)

Subsonic Compressible Flow:

- Prandtl–Glauert rule
- Compressibility effects on lift, drag, and C_p

Flow over Wings and Bodies:

- Compressibility corrections to lifting-line theory
- Gothert’s rule
- Pressure and drag estimation

Transonic Flow:

- Critical Mach number
- Drag divergence and wave drag
- Sweep and area rule
- Supercritical airfoils

Supersonic and Hypersonic Flow:

- Linearized supersonic theory
- Shock-expansion theory
- Newtonian and modified Newtonian theory

8) **Computational Fluid Dynamics** (2 hours)

- Reynolds-averaged Navier–Stokes (RANS)
- Grid generation, solution, and post-processing

9) **Exams** (3 hours)