[AE 3030] Syllabus

Aerodynamics, AE 3030, 3-0-3

Instructor Information

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General Course Information

Description

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

Course Learning Outcomes

Students will be able to

- Use analytical methods to estimate lift and drag (including viscous effects) on airfoils, wings and bodies of revolution in subsonic and supersonic flight.
- Use numerical methods to calculate aerodynamic loads and moments (including viscous effects) on 2-D and 3-D bodies n incompressible and compressible flow
- Describe physical characteristics (including momentum and thermal) of laminar and turbulent boundary layers, transition and separation

Required Course Materials

Lecture notes will be made available.

Grading Policy:

Students will complete assignments and quizzes.

90% or above: 'A'

80% to 89%: 'B'

70% to 79%: 'C'

60% to 69%: 'D'

59% or below: 'F'

Description of Graded Components

Course grade is based on assignments (30%) and two quizzes (35% each). The assignments and exams will cover the following topics.

1. Aerodynamics Intro and Course Overview (1 hour)
2. Fluid Motion Basics (1 hour)
    - Streamlines, pathlines, steady vs. unsteady, rotation and vorticity, boundary layer
3. Viscous Flow (21 hours)
    - Simple 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, factors affecting transition
    - Momentum Integral Method, Thwaites Method, Head's Method, Squire-Young formula for drag, empirical methods for transition estimate, Michel's Criteria
    - Overview of Non-Newtonian fluid effects on skin friction
    - Compressibility corrections to boundary layer equations, prediction of skin friction and heat transfer
4. Potential Flow (2 hours)
    - Derivation of Velocity Potential Equations for Compressible and Incompressible Flows
5. Low Speed Aerodynamics (15 hours)
    - Elementary solutions for incompressible Potential Flow: uniform flow, source/sink, doublet, vortex (1 hour)
    - Flow around 2-D cylinder, concept of circulation, Kutta-Joukowsky Theorem, drag in separated flow, Pressure distribution (3 hours)
6. Airfoils (6 hours):
    - Thin Airfoil Theory, Kutta Condition, Cl, Cm, lift curve slope, center of pressure, aerodynamic center
    - Overview of panel methods, numerical tools for prediction of skin friction drag around airfoils
7. Wings (5 hours):
    - Physical characteristics, trailing vortices, vortex sheet, starting vortex, downwash, induced drag, effect of aspect ratio
    - Prandtl's lifting line theory and numerical tools

- Induced drag, elliptical lift distribution, span efficiency factor, drag polars including viscous effects

8. High Speed Aerodynamics (15 hours)
    - Derivation of Linearized Potential Flow Equation, small disturbance approximations (1 hour)
    - Subsonic Flow over Airfoils (3 hours)
        i. Prandtl-Glauert Rule, compressibility corrections and effects on lift, drag and pressure distribution
    - Subsonic Flow over Wings and Bodies (3 hours)
        i. Modifications to lifting line analysis to include compressibility effects, Potential Flow
        ii. Subsonic flow over Body of Revolution using Gothert's Rule, closed form expressions for Cp and Cd
    - Transonic Effects on Airfoils, Wings and Bodies of Revolution (4 hours)
        i. Transonic flow effects on Cl, Cd, Cm and Cp, finding Critical Mach Number of airfoils and bodies of revolution, Wave drag, Drag divergence; elimination of drag rise by sweep, area rule, supercritical airfoils.
9. Supersonic and Hypersonic Flow Prediction (4 hour)
    - Determination of lift and drag using linearized supersonic flow, shock-expansion wave theory, Newtonian Theory, Modified Newtonian Theory

Course Policies

Attendance and/or Participation

Attendance is required unless excuse has been granted by the instructor for illness or Institute-approved activities.

Academic Integrity

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. Review Georgia Tech's Honor Code and the student Code of Conduct.

Any student suspected of cheating or plagiarism on a quiz, exam, or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations.

Core IMPACTS

Not applicable

Accommodations for Students with Disabilities

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

Student-Faculty Expectations Agreement

At Georgia Tech, we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. The Student-Faculty Expectations articulate some basic expectations that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.

Pre-Requisites and Co-Requisites

AE 2010, with a 'C' grade or better.

Extra Credit Opportunities

None

Collaboration, Group Work, and Use of Generative AI

All assignments are for individual grade. Collaboration with other students and.or use of generative AI tools in assignments and exams is not allowed.

Extensions, Late Assignments, & Re-Scheduled/Missed Exams

10% of the assignment penalty for each late day. Exams may be rescheduled with prior permission.

Inclement Weather and Digital Learning Days

Lectures will be given on Zoom

Student Use of Mobile Devices in the Classroom

Not allowed.

Campus Resources for Students

Academic Support: Academic Success and Advising (a unit in the Office of Undergraduate Education & Student Success) provides free support for your courses. Students can attend scheduled supplemental review (PLUS) sessions, stop by Drop-In Tutoring, or schedule a one-on-one appointment through Knack. To explore what options work best for you, please visit us online at success.gatech.edu/tutoring, email us at tutoring@gatech.edu, or come see us at Clough Undergraduate Learning Commons, Suite 283.

Student Well-Being:

At Georgia Tech, we are concerned about your overall physical, social, and mental well-being. A comprehensive list of wellness related resources has been compiled and maintained by the Office of the Vice President for Student Engagement and Well-being (student-resource-guide (gatech.edu)