AE 6060A: Syllabus

Aeroacoustics AE 6060, 3 Credits Fall 2026

Instructor Information

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Course Information

Description

- Aeroacoustics is the branch of acoustics that studies noise generation caused by turbulent fluid motion (aerodynamics) or the interaction between flows and surfaces. It focuses on how flow-induced pressure fluctuations create sound, commonly applied to reduce noise in aerospace, automotive, and industrial machinery.

Pre-requisites

- Exposure to solution of partial differential equations
- Exposure to Navier Stokes equations, general problems in fluid dynamics and consent of instructor
- Having taken a course in acoustics, vibrations theory, advanced vibration theory, or compressible flows, or turbulence, or unsteady flows, or experience with noise research will be helpful
- The course is primarily for graduate students but undergraduate students with above-mentioned exposure to advanced topics and those willing to put extra time to learn these on their own time can take it. (Consultation with the instructor is advised.)

Course LearningOutcomes

- General overview of the Course
  - Understanding of the theoretical methods used for modeling noise related to flow phenomenon
  - Working knowledge of advanced experimental methods used for identifying different sources of aerodynamic noise.
  - Hands on experience of solving aeroacoustics problems via engagement in teams of students working on various aeroacoustics topics during the tenure of the course (The topics will be selected and teams formed during the first two weeks of the class). A number of teams in the past have presented their work at conferences and published their work in journals.

- A reasonably good understanding of the following topics
  - ✓ Basics of Acoustics, Acoustics Terminology/ Various Sound Metrics/ Manipulating Decibels
  - ✓ Role of Aeroacoustics in the Modern Times
  - ✓ The Wave Equation
  - ✓ Waves in Rectangular Ducts
  - ✓ Waves in Circular Ducts
  - ✓ Liner technology basics
  - ✓ Conducting Acoustic Experiments (microphones, beamforming, impedance Measurements, etc.)
  - ✓ Instability Waves and Flow/Acoustic Interactions
  - ✓ Self-Excited Aerodynamic Noise/Resonances (Cavity Noise, Jet/Collector Interactions)
  - ✓ An overview of the Jet Noise Research- a Prelude to the Field of Aeroacoustics
  - ✓ Sources of Sound Relevant to Aerodynamic Noise
  - ✓ General Aspects of Aerodynamic Noise Theory
  - ✓ Parametric Dependence of Aerodynamic Noise
  - ✓ Jet Mixing Noise Prediction
  - ✓ Shock-Associated Noise of Supersonic Jets
  - ✓ Flight Simulations
  - ✓ Design of a Flight Simulation Facility
  - ✓ Cursory knowledge of miscellaneous topics including Rotorcraft Noise, Boundary Layer Noise/Automobile Wind Noise/Non-linear Acoustics/Sonic Boom (This will be covered if time permits. Students may be advised where to look for additional information.)

Required Course Materials

- Class Notes will be provided, for most lectures and the Hubbard book below is the recommended book
  - Harvey Hubbard, "*Aeroacoustics of Flight Vehicles: Theory and Practice*," (NASA Reference Publication; 1258) Hardcover (November 1994); Acoustical Society of America Publication; ISBN: 1563964074.
- Additional suggested reference books:
  - Dowling, A.P. and Ffowcs Williams, "*Sound and Sources of Sound*," Ellis Horwood Publishers, 1983.
  - Marvin E. Goldstein ," *Aeroacoustics*," McGraw-Hill, 1976.
  - Munjal, M. L. , "*Acoustics of Ducts and Mufflers*," John Wiley and Sons, 1987
  - Leo L. Beranek "*Noise and Vibration Control*" McGraw-Hill, 1971.
  - Samuel Temkin, "*Elements of Acoustics*," Acoustical Society of America through the American Institute of Physics (2001)
  - Stewart Glegg and William Devonport *"Aeroacoustics of Low Mach Number Flows: Fundamentals, Analysis, and Measurement,"* 1st Edition, Academic Press.

Assignment Details

Team Projects

The whole class will be broken into teams of four to five students. Members of each team will be expected to work together on (1) homework assignments , (2) a chosen simple aeroacoustics experiment as a home work , plus (3) a semester-wide research topic to be selected in consultation with the instructor.

- Students will form teams within the first two weeks of the semester and start deliberating on the topic to select.
- A team leader will be selected and individual research paper or term paper topics will be assigned
- Final Product of the team projects (to be considered the **final Exam**):
    1. Written Individual Term Papers by each student of the team
    2. A written combined Team Paper with an Appendix containing each Individual paper
    3. A Final Presentation by the team leader to the class, with a short presentation by each team member
- The Individual term papers can be very detailed literature surveys of the sub-topic selected. These can be augmented by experiments conducted by the team.
- Teams may also choose to conduct experiments or develop computer programs and animations plus simulations.
- Each team would consist of no more than four and no less than two students.
- Each team will require strengths in the following areas:
    1. Experimental Effort
    2. Computational Effort
    3. Strong Understanding of Theory, with good mathematical background
    4. Strong People skills with good technical writing skills and good presentation skills
- A hard copy and an electronic copy of the paper plus the PowerPoint Presentation will need to be prepared.

Quizzes and Exams

The quizzes and all exams are in class and closed book and closed notes. No cell phones will be allowed during the quiz or final exam.

Quiz #1: Individual conceptual assessment seeking to test your understanding of recent material.

Quiz #2 (Mid-Term): Individual assessment seeking to test your comprehension of the course material covered up to the Quiz date.

Expected **format** for homework problem solutions:

- **State what is given** – Rephrase important part of home-work problem in your own words. Present all values given in the description. Include a sketch (if necessary).
- **State what you need to find** – Concisely describe what the problem is asking you to calculate.
- **Assumptions** – List basic assumptions that will be used in solving the problem.
- **Analysis** – Show your work. Do Algebra, not Arithmetic!

Breakdown of Scoring Homework, quizzes, and Exams

- Homework Problems
    - HW #1: A team experiment or simulation in aeroacoustics (10%)
    - Hw#2, Hw #3, HW#4: Homework assignments on topics taught in the class (30%)
- One Quiz and one midterm exam
    - Quiz #1 on basic concepts (10%)
    - Quiz #2 (Midterm exam): Questions on advanced topics covered in the class (10%)
    - Individual term papers of each team project by each student (10%)
      (*to be submitted by thanksgiving*)
    - Final Exam: The final exam will consist of a formal presentation by each team of their team project and will make up 25% of the overall grade score as follows
        - Combined team term paper to be submitted on the day of the final exam (10%)
          (*It will be made up of a summary report like an AIAA paper of up to 12 pages with an appendix made up of each individual paper*)
        - A formal team presentation to the class on the day of the final exam (10%)
        - A PowerPoint of the team presentation (5%)
    - Other attributes (5%)
        - Questions asked in the class
        - Punctuality
        - Team work
        - Publishable and original research for the term papers
        - Other
- Possible Credit/bonus for Course Survey
    - Details to be announced

Grading

- A>90; B>80; C>70; D>60; F<60

Course Policies

Attendance and/orParticipation

This will be an active classroom, where you will be expected to participate. I have noticed a drastic difference in the exam performance between students who regularly attend class and those who don't. Therefore, I will count attendance in determining your final grade.

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

Core IMPACTS is the University System of Georgia's General Education curriculum. Every student in the University System of Georgia engages in a General Education curriculum – Core IMPACTS – that provides a solid foundation for life, learning, and careers, and helps you build momentum to fulfill your academic, personal, and professional aspirations. Core IMPACTS introduces the different ways we have of knowing the world and connects you to the big questions that drive your future and provide the essential skills needed to succeed. The IMPACTS Core is structured across seven areas: Institutional Priority; Mathematics and Quantitative Skills; Political Science and U.S. History; Arts, Humanities and Ethics; Communicating in Writing; Technology, Mathematics and Sciences; Social Sciences. Students are referred to career competencies. Also refer to This resource.

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.

Collaboration, Group Work, and Use of Generative AI

You are allowed to work in groups on all homework and out-of-class assignments (and you may use

my solutions), but any work you turn in must be written in your own hand. In-class tests and exams are to be your own work. All in-class tests and exams will be closed book and notes, but I will provide an equation sheet where needed.

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

Late homework will be penalized accordingly. Make-up exams are given for illness, approved Institute activities or religious observances.