

# Aeroacoustics

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*AE 774, Spring 2014, IITB Aerospace Engineering*

## Goals

Through this course you will gain an appreciation of aeroacoustics, i.e. flow-generated sound, as a component in holistic aerodynamic design. No prior familiarity with classical acoustics is assumed. By the end of the course, given a well-resolved flow field, you will be able to efficiently compute its sound field. Also, you will be in a position to delve into the current literature on aeroacoustics. The material will be theoretical in nature, with assignments involving some coding.

## Syllabus

Conservation equations, wave equation. Acoustic energy, intensity, Fourier analysis, power spectrum. One-dimensional and three-dimensional sound propagation. Sources of sound: elementary sources, monopole, dipole and multipole sources. Generalized functions, Green's function for wave equation. Acoustics of rigid solid boundaries: reciprocity theorem, Kirchhoff's formula. Sound generation by flow: Lighthill's acoustic analogy, its successors. Ffowcs Williams and Hawking's theory. Particular examples of aeroacoustics applications. Topics in classical acoustics: sound waves at a discontinuity, ray theory, resonators, acoustic nonlinearities.

## Primary reference

- Goldstein, M. E., Aeroacoustics, McGraw-Hill, 1976
- Crighton, D. G., Basic principles of aerodynamic noise generation, Prog. Aerospace Sci., 16(1), 1975 pp. 31-96

## Secondary reference

- Howe, M. S., Theory of vortex sound, Cambridge, 2003
- Pierce, A. D., Acoustics, Acoustical Society of America, 1989
- Crighton, D. G., Dowling, A. P., Ffowcs Williams, J. E., Heckl, M. and Leppington, F. G., Modern methods in analytical acoustics, Springer, 1992
- Recent literature

## Grading policy

- 40%: Homework (4 assignments, 10% each)
- 10%: Class quiz (Best 4 out of 6, 2.5% each)
- 20%: Mid-term exam
- 10%: Literature study report and presentation (5% each)
- 20%: Final exam (with questions on literature study)

Letter grades will be assigned to actual scores obtained, without any further manipulation.

**No collaboration is allowed in homeworks or project; penalty is 50% of allocated marks.**

**Submission of homeworks *after* the assigned class: penalty is 20% of allocated marks.**

## Prerequisites

Fluid dynamics