Course Type	Course Code	Name of Course	L	T	P	Credits
DE	NMED511	Fundamentals of Aeroacoustics	3	0	0	3

Course Objectives

Prerequisite: Basic knowledge of fluid mechanics, turbulent flows is essential

1. To understand the basics of flow induced noise via turbulent fluid motion / aerodynamic forces interacting with the surfaces since the area of aeroacoustics is an emerging one throughout the world.

2. It provides motivation to the students for pursuing higher studies / career related to aeroacoustics since many industries, universities and R&D sectors are working towards noise control.

Learning Outcomes

Upon successful completion of this course, students will:

1. have a broad understanding of basic concepts of aeroacoustics, governing equations.

2. have a thorough understanding of various noise sources, sound generation by flow.

3. be able to apply Lighthill's acoustic analogy, Ffowcs Williams and Hawking's theory for predicting the far-field acoustic radiations.

Unit No.	Topics to be Covered Lecture	Lecture Hours	Learning Outcomes
1	Introduction: Background and definition of aeroacoustics, Linearity of acoustics, acoustics, vortical and entropy waves	4L	To understand the background and definition of aeroacoustics, Linearity of acoustics
2	Conservation equations, Governing equations for 1-D and 3-D acoustics, Helmholtz resonator, Acoustic energy, intensity, Fourier analysis, power spectrum	6L	To understand the Governing equations for 1-D and 3-D acoustics, Basic principle of Helmholtz resonator, Fourier analysis
3	1-D and spherically-symmetric acoustics in a medium at rest, Helhmholtz equation, Sound field due to monopole, dipole and quadrupole sources, their importance and relation with oscillating spheres	5L	To understand the various sound sources, Helhmholtz equation
4	Green's function for wave equation, Green's formula, far-field approximations, compact sources and interferences	7L	To understand the compact acoustic sources, far-field approximations
5	Acoustics of rigid solid boundaries: reciprocity theorem, Kirchhoff's formula, Analysis of sound due to moving sources	5L	To understand the concepts reciprocity theorem, Kirchhoff's formula
6	Sound generation by flow: Lighthill's acoustic analogy, Ffowcs Williams and Hawking's theory	8L	To understand the concepts of Lighthill's acoustic analogy and Ffowcs Williams and Hawking's theory for the predictions of flow induced noise
7	Interaction tones, buzz-saw noise, Aeolian tones: cavity noise, Experimental aeroacoustics: Anechoic chamber, calibration procedure, acoustic sensors, aero-acoustic measurements	7L	To understand the concepts tonal and broadband noise, some basics of anechoic chamber, calibration procedure of anechoic chamber, aeroacoustic measurement techniques
	Total	**42 hrs**	

Text books

1. Goldstein, M. E., Aeroacoustics, McGraw-Hill, 1976.

2. Mueller, Thomas J. (Ed.), Aeroacoustic Measurements, Springer-Verlag Berlin Heidelberg, © 2002.

Reference books

1. Crighton, D. G., Basic principles of aerodynamic noise generation, Prog. Aerospace Sci., 16(1), 1975, pp. 31-96.

2. Howe, M. S., Theory of vortex sound, Cambridge University Press, 1st Edition, 2002.

3. Pierce, A. D., Acoustics, Acoustical Society of America, 1st Revised Edition, 1989.

4. Crighton, D. G., Dowling, A. P., Ffowcs Williams, J. E., Heckl, M. and Leppington, F. G., Modern methods in analytical acoustics, Springer, 1st Edition, 1992.

5. L. E. Kinsler, A. R. Frey, A. B. Coppens and J. V. Sanders, Fundamentals of Acoustics, John Wiley, 4th Edition.