Acoustics in Fluids AE694A

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January 4, 2018

1 Schedule

Lecture - M, W - 10-10.50 hrs, F - 12-12.50 hrs, Venue: NWTF classroom (second floor)

2 Objectives

The course aims at introducing the fundamentals of acoustic wave propagation in fluids (in particular gas). At the end of the course, a student will be able to understand and can perform preliminary calculation in regard to acoustic wave propagation, generation and dissipation.

3 Prerequisites

Undergraduate Mathematics, Fluid Mechanics, Compressible flows

4 Scoring scheme

Following is the distribution of scores for the examinations. Quiz I will take place before the mid semester examination.

No.	Examination	Percentage of the share
1	Quiz I	10
2	Mid semester	35
3	End semester	45
4	Assignments	10
	Total	100

Table 1: Scoring scheme for the course

5 Course policy

- Attendance is not compulsory and it does not contribute to the score/grade. However, it is highly recommended to attend all the classes.
- Every student will do an assignment individually. Malpractices will be penalized as per institute norms.

6 Course contents

Introduction, governing acoustic wave equation, wave propagation, wave transmission and reflection, acoustic resonators, standing and travelling waves, reflection and transmission of waves in pipes, acoustic sources, sound attenuation, applications to practical problems

7 Lecture wise breakup

No.	Topic	No. of lectures
1	Introduction to the course	1
2	**Part one: Fundamentals of acoustics** Derivation of wave equation, speed of sound, harmonic waves, acoustic energy/intensity, decibel scale, acoustic impedance, reflection and transmission at the interface of two media,	5
3	**Part two: Wave propagation** Rectangular and circular ducts, cutoff frequency, free field propagation	7
4	**Part three: Acoustics of resonators** Travelling and standing waves, boundary conditions, eigenfrequency and eigenmodes, effects of area variation, reflection and transmission of waves in pipes	7
5	**Part four: Acoustic sources** Inhomogeneous wave equation, acoustic sources: monopole, bipole & quadrupole sources, acoustic reciprocity, aeroacoustic analogies	9
6	**Part five: Attenuation of sound** Viscous and thermal conduction losses, absorption coefficient, sound absorption in pipes	5
7	**Part six: Application of principles of acoustics** Aeroacoustic jet noise, combustion instability, fan/rotor noise	6
	Total lectures	40

Table 2: Lecture wise breakup. Each lecture is for a duration of 50 minutes.

8 Text books

The following are the text books for this course.

1. Lawrence E. Kinsler, Austin R. Frey, and Alan B. Coppens, 2000. *Fundamentals of acoustics*. 4th edn. John-Wiley & Sons, Inc.
2. Tim C. Lieuwen, 2012. *Unsteady combustor physics*. 1st edn. Cambridge University Press.
3. Philip M. Morse and K. Uno Ingard, 1986. *Fundamentals of acoustics*. 1st edn. Princeton University Press.
4. S.W. Rienstra & A. Hirschberg, 2000. *An introduction to acoustics*. http://www.win.tue.nl/ sjoerdr/papers/boek.pdf
5. S.W. Rienstra & A. Hirschberg, 2004. *An introduction to aeroacoustics*. http://www.win.tue.nl/ sjoerdr/papers/les-swr-mh.pdf

9 Office hours

- Outside formal contact hours, students can contact me through email: sathesh@iitk.ac.in
- An appointment can be fixed and detailed discussion/clarification can then be made.
- Walking to my office without prior appointment (unless extremely important) is highly discouraged.
- Minor clarifications can be taken up just before and after the lecture.