



ACOUSTIC MATERIALS AND METAMATERIALS

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IIT Roorkee

PREREQUISITES : Mathematics (up to Class 12th), Physics (up to Class 12th)

INTENDED AUDIENCE : Students and researchers in "Mechanical Engineering, Materials Engineering, Acoustics, Architecture

INDUSTRIES APPLICABLE TO : ARCI, TATA Advanced Materials Limited, Huntsman Corporation, IACS, Materials Research Society of India (MRSI), Acoustic consultants, Advanced materials manufacturers, Speech transmission industry.

COURSE OUTLINE :

The study of electromagnetic and acoustic waves is an endeavor that dates back centuries. An important sub-domain of this field that affects our daily life is the use of acoustic principles to control environmental noise. In this regard, acoustic materials, which are materials designed to manipulate sound wave propagation, are of prime importance. Within this field, about three decades ago, the concept of metamaterials was proposed that has created a revolution. Theoretical formulation and experiments have shown the feasibility of realizing man-made acoustic metamaterials that can manipulate waves beyond the defined limits of those found in nature. Therefore, within a time span of 15 years, acoustic materials have emerged as an active field driven by scientific discoveries and diverse application potentials in machinery noise control, frequency filtering, speech transmission technology, acoustic imaging, and cloaking. This is the first-ever organized coursework on acoustic materials with a special focus on acoustic metamaterials. This course will cover the following topics:

- Acoustic fundamentals
- Theory and design principles of acoustic barrier materials, sound absorbing materials
- Limitations of conventional materials
- Principles of acoustic metamaterials
- Theory and design principles of membrane type metamaterials, of sonic crystals
- Guidelines for selecting acoustic materials

ABOUT INSTRUCTOR :

Hello, I am Dr. Sneha Singh, an Assistant Professor at the Department of Mechanical & Industrial Engineering, IIT Roorkee. I have obtained my Ph.D. with highest honours from the University of Warwick in 2016 in the area of Automotive Sound Quality, and by B.Tech. (Honours) from IIT Kharagpur in Manufacturing Science and Engineering in 2011. I am an author of 13 international journal papers of high repute and 19 international conference papers. I thoroughly enjoy teaching. During my PhD, my post Doc at IIT Kharagpur & IIT Bombay, and as Assistant Professor at IIT Roorkee, I have taught courses on Automotive Engineering, Acoustics and Noise Control, Kinematics and Dynamics of machines, Theory of Machines, Machine Design, Theory of Production Processes, Engineering Analysis & Design, and Design for Safety & Comfort. Further I have been a guest lecturer at lecture series on Acoustics & Industrial Noise Control at GIAN-IIT Kharagpur. My video lectures are available online at <https://www.youtube.com/watch?v=iqVYIq96tB4> Currently, I am pursuing research on Acoustic Metamaterials, and Noise Source Identification.

COURSE PLAN :

Week 1: Acoustics fundamentals , Sound propagation in fluids

Week 2: Advanced concepts in acoustics, Sound signal analysis, Principles of Noise control

Week 3: Acoustic materials, Enclosures, Barriers, Absorbers

Week 4: Porous sound absorbers, Panel absorbers, Helmholtz resonators, Perforated panel absorbers

Week 5: Micro-perforated panel absorbers, Limitations of conventional acoustic materials

Week 6: Acoustic metamaterials, Membrane type acoustic metamaterials

Week 7: Membrane type acoustic metamaterials(cont'd), Introduction to Sonic crystals

Week 8: Sonic crystals(cont'd), Guidelines for material selection