

MECH_ENG 495/CIV_ENV 495
Elastic Wave Propagation in Periodic Media

Quarter Offered

Spring, TTh 3.30PM-4.50PM

Prerequisites

Graduate Standing, Senior undergraduate or permission of instructor

Description

This course is designed to provide a theoretical background on the propagation of elastic stress waves in solids with periodic variation in geometry or elastic properties, a review of experimental techniques for actuation and detection of elastic waves, and an overview of state-of-the-art applications of wave propagation in linear and nonlinear periodic media.

Who takes this course

The course content is tailored to senior undergraduate and graduate students majoring in civil engineering, mechanical engineering, applied mathematics, and physics.

What is the course about?

The course provides a basic understanding of approaches to exploit geometry and mechanical properties in the context of periodic structures to realize novel system behavior. Some applications of these structures include, sound insulation in buildings for earthquake protection, vibration cloaking of sensitive components, super-resolution imaging using elastic or acoustic waves, multifunctional sensors and actuators for controlling vibration of beams and plates, and energy conversion. In this course, we will explore analytical and numerical approaches to design and study the behavior of elastic waves in complex periodic structures. The course has the potential to serve as a spring board for pursuing research in the growing field of elastic metamaterials and periodic structures.

Mini Syllabus

- Introduction to stress waves in a 1D elastic continuum
- Concepts of wave dispersion, group velocity, phase velocity
- Experimental methods
- Finite element simulation of stress waves in solids
- Wave propagation in 1D and 2D atomic chains
- Design of phononic structures and metamaterials
- Review of the state-of-the-art (phononic bandgaps, acoustic filters, topological insulators, etc.)

Reference Textbooks

Class notes will be provided. We will consult chapters from the references below

- J.D. Achenbach, *Wave Propagation in Elastic Solids*
- K.F. Graff, *Wave Motion in Elastic Solids*
- L. Brillouin, *Wave Propagation in Periodic Structures*, 1953

- M. Maldovan, E.L. Thomas, *Periodic Materials and Interference Lithography for Photonics, Phononics and Mechanics*, by Wiley-VCH.
- J.F. Doyle, J.F., *Wave Propagation in Structures*, Springer, NY, 1989