

ASEN 5519 Special Topics: Introduction to Phononics (Fall 2018)
(Formally, Special Topics: Vibrations in Mechanics and Physics)

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Schedule: TTh 5:00-6:15 pm, Engineering Classroom Wing 1B08 **Office Hours:** By Appointment

Objective and Scope:

This course will provide an advanced exposure, coupled with hands-on development, of concepts and techniques in the theory of phonons with a focus on vibrations, wave propagation, and transport in periodic materials. Motivated by the growing interest in interdisciplinary research, the course will take a unique perspective of approaching the topic from both the mechanics and physics points of view, hence multiple system size scales will be considered ranging from the continuum to the atomistic. This approach promises to broaden the potential for cross-flow of ideas and the development of novel insights, techniques and applications, particularly in the emerging areas of *nanomaterials* and *metamaterials*.

Topics (tentative):

Intro to course; intro to phononics at macro and nanoscales; motivation and applications

Macroscale Phononics (Vibrations in Mechanics)

Discrete models: Vibration/dispersion analysis of finite/infinite systems

Single-DOF and multi-DOF systems

Modal analysis (mode superposition and selection):

Treatment of damping (non-proportional and general)

Vibration absorber and locally resonant elastic metamaterials

Continuous models: Vibration/dispersion analysis of finite/infinite systems

Transfer matrix method (undamped and damped)

Finite element method (undamped and damped; steady-state vibrations, wave simulation, and dispersion)

Introduction to multi-dimensional lattices: Symmetry, Brillouin zone,

Applications of macroscale phononic crystals and elastic metamaterials

Nanoscale Phononics (Vibrations in Physics)

Basic crystallography and interatomic potentials

Lattice dynamics: dispersion, mode shapes, and density of states

Thermal transport: thermal conductivity prediction; physical phenomena

Research and development outlo

Course Themes:

Discrete vs. continuous models

Macroscale vs. nanoscale models

Steady-state vibration vs. wave simulation vs. dispersion descriptions of the dynamics

Analytical (e.g., transfer-matrix) vs. numerical (e.g., finite-element) methods

Mathematics and physics of vibrations and wave propagation with a focus on the phenomena of dispersion, resonance, dissipation, and nonlinearity

Intersection of disciplines between mechanics (elastodynamics) and physics (condensed matter physics)

Statements on University Rules and Regulations:

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