LUNDS UNIVERSITET
Lunds Tekniska Högskola

Course syllabus

Fysisk akustik
Physical Acoustics

BMEN45, 7,5 credits, A (Second Cycle)

Valid for: 2023/24
Faculty: Faculty of Engineering, LTH
Decided by: PLED BME
Date of Decision: 2023-04-13

General Information

Elective for: BME4-bf, E4, F4, N4
Language of instruction: The course will be given in English

Aim

The aim of the course is to provide fundamental knowledge about mathematical and physical methods that are routinely applied in research and industry to model acoustics, i.e., linear wave or vibrational, phenomena. Knowledge on several topics in basic mechanics, linear wave propagation, and discrete oscillating systems will be provided. The course aims at providing the capability to devise simple models of those vibrational phenomena and describe them in a mathematical language, which allows the students to derive simple solutions either numerically or analytically. The knowledge forms a thorough foundation of the physics that is applied in different applications of acoustics. This course also has the purpose to prepare the students for diploma work or Ph.D. research in the relevant fields.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- Demonstrate a thorough understanding of the basic physical and mathematical principles used in physical acoustics.
- Understand how the axioms of mechanics lead to the wave equation.
- Be able to interpret the analytically derived results from a physics point of view.
- Establish a satisfactory overview of the technical applications of acoustics.

Competences and skills
For a passing grade the student must

- Be able to solve the wave equation analytically in simple cases.
- Be able to read, understand, summarize, and discuss scientific papers in physical acoustics.
- Be able to formulate and solve problems in acoustics numerically and analytically.
- Be able to apply numerical tools to model problems in acoustics.

Judgement and approach
For a passing grade the student must

- Be able to judge the quality of a theoretical/numerical analysis of an acoustical phenomenon.

Contents

Discrete systems, wave equation, plane waves, spherical waves, cylindrical waves, transducers, nonlinear acoustics, finite element method, applications.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: Pass compulsory parts, including assignments, numerical laboratories, and mini-projects, as well as oral examination.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Parts
Code: 0123. **Name:** Examination.
Credits: 4,5. **Grading scale:** TH. **Assessment:** Graded exam. **Contents:** Oral exam.
Code: 0223. **Name:** Assignments, Numerical Labs, Mini-projects.
Credits: 3. **Grading scale:** UG. **Assessment:** Approved assignments, completed laboratory work with approved laboratory report, approved mini-project report and presentation. **Contents:** Assignments, laboratory works with reports, report and presentation of mini-project.

Admission

Assumed prior knowledge: Fundamental knowledge in mathematics and physics, including single variable and multivariable calculus, linear algebra, and classical mechanics.
The number of participants is limited to: 32
Selection: Number of credits within the programme. Priority is given to students whose program has the course listed in its curriculum and timetable.

Reading list

- David T. Blackstock: Fundamentals of Physical Acoustics. Wiley-Interscience, 2000, ISBN: 978-0-471-31979-5. Fundamentals of Physical Acoustics is suitable for advanced undergraduate students or graduate students. Mathematical results and physical explanations go hand in hand, and a unique feature of the book is the balance it strikes between time-domain and frequency-domain presentations. Emphasis on plane waves in the first part of the book keeps the mathematics simple yet accommodates a broad range of topics: propagation, reflection and transmission, normal modes and simple waveguides for rectilinear geometries, horns, inhomogeneous media, and sound absorption and dispersion. The second part of the book is devoted to a more rigorous development of the wave equation, spherical and cylindrical waves (including the more advanced mathematics required), advanced waveguides, baffled piston radiation, diffraction (treated in the time domain), and arrays.
- Lawrence E. Kinsler, Austin R. Frey, Alan B. Coppens, James V. Sanders: Fundamentals of Acoustics. John Wiley & Sons, 2000, ISBN: 978-0-471-84789-2. Fundamentals of Acoustics is designed for a one semester junior/senior/graduate level course in acoustics. It presents the physical and mathematical concepts related to the generation, transmission and reception of acoustic waves, covering the basic physics foundations as well as the engineering aspects of the discipline.

Contact and other information

Course coordinator: Wei Qiu, wei.qiu@bme.lth.se
Course coordinator: Thierry Baasch, thierry.baasch@bme.lth.se
Further information: Lecture notes will be provided in the course. The suggested course literature are not mandatory.