FSK3540 Physics and Applications of Ultrasound 6.0 credits

Ultraljudsfysik och tillämpningar

This is a translation of the Swedish, legally binding, course syllabus.

Establishment

Course syllabus for FSK3540 valid from Spring 2010

Grading scale

G

Education cycle

Third cycle

Specific prerequisites

Admitted to PhD studies in Physics, Biological Physics, or related fields of study.

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

The course deals with basic physical principles and technological applications of ultrasound. A majority of the applications discussed are biomedical. In addition to the lectures, there is one lab and one project in the course.

After the course is completed, the student should be able to:

- describe acoustic quantities and their relationships, namely: displacement, pressure, particle velocity, phase velocity, acoustic impedance, absorption, energy density and intensity
- perform calculations with the above quantities in order to design an ultrasonic transducer and optimize it for a given set of specifications
- describe the properties of different acoustic wave modes, including longitudinal waves, shear waves, Rayleigh waves and Lamb waves
- describe the basic physical principles behind, and give examples of applications of non-linear effects, for example: acoustic radiation pressure, acoustic streaming, cavitation and sonoluminescence
- explain the physical background of, and describe the system design for different industrial and biomedical application areas discussed in the course (see Main content)
- where applicable, compare and assess the ultrasonic applications with alternative available techniques.

Course contents

**Lectures
****Physical principles of acoustic wave propagation**: Wave equation. Acoustic quantities: displacement, velocity, pressure, phase velocity, acoustic impedance, energy and intensity. Acoustic wave modes: bulk waves, Rayleigh waves and Lamb waves. Reflection, refraction and transmission. Absorption and attenuation. Diffraction, near field and far field. Non-linear effects. Acoustic streaming. Cavitation. Sonoluminescence. Piezoelectricity and piezoelectric materials. Biological effects of ultrasound.

Instrumentation: Transducers. Sensors. Acoustic properties of materials. Waveguides and resonators. Acoustic lenses and mirrors.

Applications of ultrasound: Diagnostics/imaging. Doppler. Material testing and industrial applications. High power applications. Sonar. Acoustic microscopy. Micro-cleaning and grinding. Drilling. MEMS. Laser ultrasound. Chemical applications. Agglomeration and particle manipulation.

**Lab
****The lab is performed in groups of two students, and is presented by a written report.

Project
A project is chosen within an elective but by the coordinator accepted subject. The project is presented as a written report and also as a 20-min oral presentation for the other students. The other students are supposed to provide opposition to the oral presentation.

Course literature

Course compendium supplied by the coordinator.
Complement: L. E. Kinsler, A. R. Frey, A. B. Coppens and J. V. Frey, Fundamentals of Acoustics, John Wiley & Sons, Inc.

Examination

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

If the course is discontinued, students may request to be examined during the following two academic years.

FÖR1 - Assignment, 2.0 credits, grade scale: P/F
LAB1 - Laboratory Work, 1.0 credits, grade scale: P/F
TEN1 - Examination, 3.0 credits, grade scale: P/F

Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.