FSK3886 Semiconductor and Nano-Optics 6.0 credits

Halvledar och nanooptik

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

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

Establishment

Course syllabus for FSK3886 valid from Spring 2017

Grading scale

Education cycle

Third cycle

Specific prerequisites

Enrolled as PhD student. Knowledge of basics of optics and solid state physics.

Language of instruction

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

Intended learning outcomes

During the course, the students will learn the basics of semiconductor optics. The studied topics include properties of electronic and phonon optical transitions in bulk materials and nanostructures, and as well as electric field and nonlinear effects. In addition, the students will examine some topics that are at the frontiers of contemporary nanooptics. The students will thoroughly analyse the near field radiation and its applications in microscopy and nanophotonics and familiarise themselves with optical properties of metals (plasmonics). After the completed course, the students should be able to:

- Have basic knowledge about band structure of semiconductor materials, free and bound carriers, excitons, plasmons and phonons, and their influence on optical spectra.
- Define distinctions between direct and indirect, radiative and nonradiative, and allowed and forbidden transitions in semiconductors and their nanostructures.
- Calculate exciton transition energies and energy levels in quantum wells.
- Define distinctions and common features between far and near field light, nano- and conventional optics.
- Characterise near field optical microscopy conditions needed to evaluate such optical properties as luminescence, transmission and refraction. This includes identifying advantages and drawbacks of the technique and making optimal tradeoffs for specific tasks.
- Describe basics and identify important issues in technology and applications of semiconductor nanostructures and plasmonic structures.
- Determine conditions of plasmon generation in planar and spherical plasmonic structures

Course contents

The topics of the course include:

- Basics of crystalline and band structure of semiconductor materials, free and bound electrons and holes, excitons, plasmons and phonons.
- Optical measurement techniques.
- Interband, intraband, excitonic and phonon optical transitions.
- Semiconductor nanostructures, including technology and optical properties of quantum dots.
- Properties of the near field radiation, including generation, detection and analysis.
- Principles of operation and construction of a scanning near field optical microscope.
- Plasmonics of thin metallic layers and nanoparticles.

Disposition

The course consists of 11 two-hour lectures and a demonstration lab. After every lecture, the students are given homework problems.

Course literature

Mark Fox, Optical Properties of Solids (Oxford University Press, 2001, 2010).

Supplementary literature:Chapters from M. Ohtsu and K. Kobayashi, Optical Near Fields (Springer, Berlin, 2004), and research papers. Supplementary literature is handed out during the course.

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.

The final exam has the form of a final home assignment.The final home assignment requires a more sophisticated analysis and synthesis of the course material. Its successful completion indicates that a student is able to link different course topics, can evaluate them critically and make trade-offs in real life experimental situations.

Other requirements for final grade

At least 60% of points on homework assignments and 60% on the final home assignment are required to pass the course.
Courses grades are pass and fail.

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.