SK2766 Semiconductor- and Nano-Optics 6.0 credits

Halvledar- och nanooptik

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

Establishment

Course syllabus for SK2766 valid from Autumn 2017

Grading scale

A, B, C, D, E, FX, F

Education cycle

Second cycle

Main field of study

Engineering Physics

Specific prerequisites

Bachelor's degree in physics, electrical engineering or an equivalent degree. Basics of optics (e.g., course IO2651, SK2302 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.

Besides, the students will improve their literature search, seminar preparation and presentation skills.

Course contents

The course is foreseen for MSc and postgraduate students. The course is freely selectable in MSc programme in Photonics. It is also a part of the Erasmus Mundus Masters programme in Photonics. The course is given in English.

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 (SNOM).

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).

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

- TEN1 - Exam, 6.0 credits, grading scale: A, B, C, D, E, FX, F

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.

5 hour written exam. Part of the total grade comes from home assignments, 6.0 cr, grading scale: A, B, C, D, E, FX, F.

For PhD students, the exam has the form of the final home assignment. Grading: pass, fail

Other requirements for final grade

33% of the final grade will come from the homework results and 67% - from the final exam. To pass, the students should deliver all the homework on time and receive at least 60 % of total points, and reach the required number of points for the homework and the exam. Distinction between the higher grades D and A will be made according to the points received for solving homework and exam problems, and the overall activity during the course. Over 80% result in homework is worth one exam problem.

For PhD students, the grading is pass (G) or fail (U). The final exam has a form of the final home assignment. To pass, the final home assignment is obligatory with a 60% of the total amount of points. 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 tradeoffs in real life experimental situations.

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.