SK2901 Quantum Materials and Devices 7.5 credits

Kvantiserade material och komponenter

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

Establishment

Course syllabus for SK2901 valid from Autumn 2018

Grading scale

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

Education cycle

Second cycle

Main field of study

Engineering Physics

Specific prerequisites

Basic understanding of the physics and chemistry of materials. Basic knowledge in solid state physics (Kittel) (IM26511 orIM2601) and of semiconductor physics and devices (2B1252 or IH2651).

Language of instruction

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

Intended learning outcomes

The goals of the course are:

- The student should be able to describe certain quantum systems and building blocks such as: low-dimensional semiconductors, heterostructures, carbon nanotubes, quantum dots, nanowires etc.
- The student should be able to set up and solve the Schrödinger equation for diferent types of potentials in one dimension as well as in 2 or 3 dimensions for specific cases.
- The student should be able to use matrix methods for solving transport problems such as tunneling, resonant tunneling and know the concept of quantized conductance.
- The student should be able to experimentally use AFM and PL methods and describe approximate performance as well as applications.
- Finally, a goal is that the student should be able to describe present research front in quantum materials, devices and nanooelectronic systems and be able to critically assess future trends.

Course contents

The course reviews the trends in low dimensional structures which use quantum phenomena to realize new functions or devices and new basic building blocks. These aim at electronic, opto-electronic and new bio applications. New approaches to nanoelectronic systems will also be overviewed.

Syllabus: Introduction, refresh in basic quantum mechanics and solid state physics, low-dimensional semiconductors, density of states, quantum wells and heterostructures, quantum wires, quantum dots, nanocrystals, optical properties, absorption, luminescence, transport including tunneling in low-dimensional semiconductors, single-electron devices, calculation methods, fabrication methods, analyses techniques, applications, physical limits in nano-electronics, nanoelectronic systems, new approaches to replace CMOS etc.

Course literature

The physics of low-dimensional semiconductors, John Davies, Cambridge, 1998, ISBN: 0-521-48491-X

Lecture and tutorial materials and lab instructions

Examination

- TEN1 - Examination, 6.0 credits, grading scale: A, B, C, D, E, FX, F
- LAB1 - Laboratory work, 1.5 credits, grading scale: P, 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.

- Written exam (TEN1) giving 6 credits, grading: A-F, The exam consists of a theoretical part without any books/tables and a calculation part where course book can be used

- Two voluntary control exams which may give bonus credits to the written exam

- A compulsory lab course (LAB1) with two labs giving 1,5 credits

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.