Nanophysics

Nanofysik
6 credits

Programme course

TFYM03

Valid from: 2025 Spring semester

Determined by	**Main field of study**	
Board of Studies for Electrical Engineering, Physics and Mathematics	Applied Physics, Physics	
Date determined	**Course level**	**Progressive specialisation**
2024-08-28	Second cycle	A1F
Revised by	**Disciplinary domain**	
	Technology	
Revision date	**Subject group**	
	Physics	
Offered first time	**Offered for the last time**	
Autumn semester 2021		
Department	**Replaced by**	
Institutionen för fysik, kemi och biologi		

Specific information

The course can not be included in degree together with TFYA91, TFYY54.

Course offered for

- Master of Science in Applied Physics and Electrical Engineering - International
- Master of Science in Applied Physics and Electrical Engineering

Prerequisites

Solid state physics.

Intended learning outcomes

The aim of this course is to give an introduction to the semiconductor physics at the nanometer scale. The participants in the course obtain basic understanding of the principles, fabrication and characterization methods, and application aspects of low-dimensional semiconductor structures. After the course the students should be able to:

- define the fundamental physical principles, which govern properties of the semiconductor materials and predict the effects of reduced dimensionality on optical, electronic and transport-related properties in quantum structures
- describe and evaluate the different fabrication methods of semiconductor nanostructures - quantum wells, quantum wires and quantum dots
- apply imaging and optical characterization techniques, perform analysis of the obtained information and write a lab report in English
- explain the operation principles of nanoelectronic and nanophotonic devices and identify the their area of applications.

Course content

A. Introduction to the semiconductor physics and nanostructures – scaling laws at nanoscale; quantum nature of nanoworld; semiconductor band structure and effective masses; phonons, free charge cariers and scattering processes; quantized electronic levels in quantum wells, quantum wires and quatum dots.

B. Fabrication and characterization of semiconductor nanostructures - epitaxial techniques for growth of quantum wells, quantum wires and quantum dots; imaging techniques for structural analysis of semiconductor nanostructures; spectroscopic methods for characterization of quantized electronic levels; local probe spectroscopy.

C. Properties and application of semiconductor nanostructures - optical properties of quantum wells, quantum wires and quantum dots - absorption, emission, excitons, carrier relaxation and recombination; quandum electon transport in semiconductor heterostructures (two-dimensional electron gas) and in quantum wires (ballistic transport); nanophotonic devices - light-emission diodes, laser diodes, photodetectors and solar cells; nanoelectronic devices - high-mobility field-effect transistors, resonant tunneling diodes, single-electron transistors.

Teaching and working methods

Lectures and laboratory exercises. Project work based on a literature survey of a special topic in nanophysics.

Examination

UPG1	Assignments	3 credits	U, G
LAB1	Laboratory Work	1 credits	U, G
UPG2	Project Work	2 credits	U, 3, 4, 5

Grades

Four-grade scale, LiU, U, 3, 4, 5

Other information

About teaching and examination language

The teaching language is presented in the Overview tab for each course. The examination language relates to the teaching language as follows:

- If teaching language is “Swedish”, the course as a whole could be given in Swedish, or partly in English. Examination language is Swedish, but parts of the examination can be in English.
- If teaching language is “English”, the course as a whole is taught in English. Examination language is English.
- If teaching language is “Swedish/English”, the course as a whole will be taught in English if students without prior knowledge of the Swedish language participate. Examination language is Swedish or English depending on teaching language.

Other

The course is conducted in such a way that there are equal opportunities with regard to sex, transgender identity or expression, ethnicity, religion or other belief, disability, sexual orientation and age.

The planning and implementation of a course should correspond to the course syllabus. The course evaluation should therefore be conducted with the course syllabus as a starting point.

The course is campus-based at the location specified for the course, unless otherwise stated under “Teaching and working methods”. Please note, in a campus-based course occasional remote sessions could be included.