Semiconductor Physics

Programme course

6 credits

Halvledarfysik

TFYY47

Valid from: 2017 Spring semester

Determined by
Board of Studies for Electrical Engineering,
Physics and Mathematics

Date determined
2017-01-25

Main field of study

Applied Physics, Physics

Course level

Second cycle

Advancement level

A1X

Course offered for

- Applied Physics and Electrical Engineering, M Sc in Engineering
- Physics and Nanoscience, Master's programme
- Materials Science and Nanotechnology, Master's programme
- Applied Physics and Electrical Engineering - International, M Sc in Engineering

Entry requirements

Note: Admission requirements for non-programme students usually also include admission requirements for the programme and threshold requirements for progression within the programme, or corresponding.

Prerequisites

Physics of Condenced Matter, Quantum Mechanics.

Intended learning outcomes

The objective of the course is to transfer a basic understanding for fundamental properties and characteristics for semiconductors, but also how these properties can be utilized for various applications within the electronics. Within the frame of the course, a description of the most important methods to fabricate semiconductor materials together with introducing doping in the material will be provided. The course aims at an improved understanding of the effects caused by a reduction of the dimensionality of a semiconductor; from the 3-dimensional bulk, via 2- and 1-dimensional quantum wells and -wires, to 0-dimensional quantum dots.

Knowledge and understanding:
After the course, the student should

- understand and describe in own words the optical, electrical and transport related properties of the semiconductors
- describe different types of doping and the effect of doping for various properties in the semiconductors
- understand and describe in own words the effect of a reduced dimensionality in a semiconductor
- describe different lattice types and energy band models, which are applicable on semiconductors

Applications and evaluation: After the course, the student should

- be able to calculate parameters like the charge carrier concentration, Fermi-energy, doping levels and –energies together with the mobility as evaluated from experimental results
- demonstrate an ability to independently select and employ adequate computational methods in order to determine the doping energies for bulk as well as quantization effects in semiconductor quantum structures
- be able to use some common electrical and optical characterization methods on semiconductors

Ability to communication: After the course, the student should

- be able to write a laboration report with an analysis of experimental results and error sources together with an estimate of error levels
- be able to find and utilize adequate and relevant information from a simpler scientific article and be able to give an oral presentation of this information

Course content

A. Semiconductors: Bandstructure, Phonons, Defects, Impurities, Transport Properties, Hall Effect, Scattering Processes, Optical Properties, Recombination Mechanisms, Excitons, Auger-Processes, Characterisation Methods (Optical, Electrical, Magnetic Methods), External Field Perturbations (Electrical field, Magnetic field).
B. Quantum structures: Heterostructures, Super-lattices, Quantum Wells, Quantum Hall Effect, Stark Effect, Growth Methods (Epitaxial Methods, Doping Methods), Quantum wires and dots.
C. Laborations

1. Luminescence measurements
2. Optical Characterisation using Fourier Transform Spectroscopy

Teaching and working methods

The course is organized in lectures, lessons and laboratory exercises. The lessons concern mainly problem solving, but also to some extent demonstrations of research facilities. The laboratory exercises involve methods for characterization of semiconductor materials and heterostructures. Study trip to some semiconductor related company / research lab may be arranged.

Examination

TEN1	Examination	U, 3, 4, 5	4 credits
LAB1	Laboratory Work	U, G	2 credits

Grades

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

Department

Institutionen för fysik, kemi och biologi

Director of Studies or equivalent

Magnus Johansson

Examiner

Fredrik Karlsson

Course website and other links

http://www.ifm.liu.se/undergrad/fysikgtu/coursepage.html?selection=all&sort=kk

Education components

Preliminary scheduled hours: 54 h
Recommended self-study hours: 106 h

Course literature

Additional literature

Books

M. Grundmann, *The physics of Semiconductors*

Common rules

Regulations (apply to LiU in its entirety)

The university is a government agency whose operations are regulated by legislation and ordinances, which include the Higher Education Act and the Higher Education Ordinance. In addition to legislation and ordinances, operations are subject to several policy documents. The Linköping University rule book collects currently valid decisions of a regulatory nature taken by the university board, the vice-chancellor and faculty/department boards.

LiU's rule book for education at first-cycle and second-cycle levels is available at http://styrdokument.liu.se/Regelsamling/Innehall/Utbildning_pa_grund-_och_avancerad_niva.