LUNDS UNIVERSITET
Lunds Tekniska Högskola

Course syllabus

Fysiken för låg-dimensionella strukturer och kvantkomponenter
The Physics of Low-dimensional Structures and Quantum Devices

FFFN35, 7,5 credits, A (Second Cycle)

Valid for: 2023/24
Faculty: Faculty of Engineering, LTH
Decided by: PLED N
Date of Decision: 2023-04-17

General Information

Main field: Nanoscience.
Compulsory for: MNAV1, N4-nf
Elective for: E4, F4, F4-nf, MFOT1, N4-hn
Language of instruction: The course will be given in English

Aim

The general aim of the course is to give advanced knowledge of artificial materials with structures on the nanometer scale, where the movement of the electrons is limited to two, one or zero dimensions, primarily but not exclusively in semiconductors.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- be able to describe and explain physics phenomena in low-dimensional semiconductor heterostructures.
- be able to calculate and explain the fundamental electronic structures of realistic heterostructures using quantum mechanical models
- be able to calculate optical and transport properties of 0-, 1- and 2-dimensional systems
- be able to describe applications of low dimensional structures in areas such as photonics and electronics.

Competences and skills
For a passing grade the student must

- be able to analyze advanced experiments and compare the results with realistic calculations
- be able to plan, implement and evaluate an advanced research project
- be able to write well structured reports that summarize, explain and analyze experimental and/or theoretical work
- be able to present own results in an oral talk.

Judgement and approach
For a passing grade the student must

- be able to independently search for information beyond the reading list
- be able to choose approximations and models based on experience and knowledge of physics in a general sense.

Contents

The course covers artificial materials with structures on the nanometer scale, where the movement of electrons is limited to two, one or zero dimensions. The emphasis lies on heterostructures in semiconductors, but other low dimensional systems are also discussed. Concepts and fundamental theory are introduced based on quantum mechanics, deepened by application on heterostructures.

The course provides in-depth knowledge of:

- Concepts about heterostructures and resulting low dimensional systems, such as quantum wells, nanowires and quantum dots
- Quantum physics applied to such systems
- Optical properties of low dimensional systems (transition rules, polarisation etc)
- Electron transport properties of 2D and 1D systems
- Quantised conductance with Landauer-formalism
- Devices based on quantum phenomena and Coulomb blockade.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: Written exam and home assignments. Graded laboratory exercises and project work. The final grade is based on a weighted average of the grades on the laboratory work (25%), the project work (25%) and the written exam (50%).

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Parts
Code: 0117. **Name:** Project.
Credits: 2. **Grading scale:** UG. **Assessment:** Execution and written and oral presentation
Code: 0217. **Name:** Laboratory Exercises.
Credits: 1,5. **Grading scale:** UG. **Assessment:** Written reports

Code: 0317. **Name:** Written Examination.
Credits: 4. **Grading scale:** TH. **Assessment:** Written exam

Admission

Assumed prior knowledge: (FMFF15 Quantum Mechanics and Mathematical Methods or FAFF10 Atomic and Nuclear Physics with Applications) and (FFFF01 Electronical Materials or FFFF05 Solid State Physics).
The number of participants is limited to: No
The course overlaps following course/s: FFF042

Reading list

- Davies, J H: The Physics of Low-dimensional Semiconductors: An Introduction. Cambridge University Press 1997. ISBN: 052148491X.
- Lecture notes.

Contact and other information

Course coordinator: Mats-Erik Pistol, mats-erik.pistol@ftf.lth.se
Course coordinator: Adam Burke, adam.burke@ftf.lth.se
Course homepage: https://canvas.education.lu.se/