Faculty of Science

FYST79, Physics: The Physics of Low-dimensional Structures and Quantum Devices, 7.5 credits

Fysik: Fysiken för lågdimensionella strukturer och kvantkomponenter, 7,5 högskolepoäng

Second Cycle / Avancerad nivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2022-12-12 to be valid from 2022-12-12, autumn semester 2023.

General Information

The course is an elective course for second-cycle studies for a Degree of Master of Science (120 credits) with a specialisation in physics.

Language of instruction: English
The course is given in English.

Main field of studies	*Depth of study relative to the degree requirements*
Physics	A1N, Second cycle, has only first-cycle course/s as entry requirements

Learning outcomes

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.

Knowledge and understanding

On completion of the course, the students shall be able to:

- describe and explain physical phenomena in low-dimensional semiconductor heterostructures
- calculate and explain the fundamental electronic structures of realistic heterostructures using quantum mechanical models
- calculate optical and transport properties of 0-, 1- and 2-dimensional systems

- describe applications of low dimensional structures in areas such as photonics and electronics.

Competence and skills

On completion of the course, the students shall be able to:

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

Judgement and approach

On completion of the course, the students shall be able to:

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

Course content

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
- Scattering phenomena in 1D
- Devices based on quantum phenomena and Coulomb blockade.

Course design

The teaching consists of lectures, calculation exercises, laboratory sessions and research projects. Participation in laboratory sessions and project work and other teaching integrated with these is compulsory. After the lecture part of the course is completed, the student carries out a project work in a research group for about 1.5 weeks.

Assessment

Examination takes place in writing in the form of laboratory reports during the course, in writing and orally in the form of a presentation of project during the course and in the form of written examination at the end of the course.

Students who do not pass a regular assessment will be offered another opportunity for assessement soon thereafter.

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.

Subcourses that are part of this course can be found in an appendix at the end of this document.

Grades

Marking scale: Fail, Pass, Pass with distinction.
To pass the entire course, approved examination, approved laboratory reports, passed project work and participation in all compulsory parts are required.

The grading scale for the written assignments is Failed, Passed, while examination is graded according to the grading scale failed, passed, Passed with distinction.

The final grade is given by a weighted average of the included parts, with the following weights: written examination 50%, laboratory reports 25%, project work 25%.

Entry requirements

Admission to the course requires 75 credits in physics and 45 credits in mathematics, or a bachelor's degree in physics or equivalent - in both cases including knowledge equivalent to FYSB22 Basic Quantum Mechanics, 7.5 credits and FYSC23 Solid State Physics, 7.5 credits. Furthermore is required English 6/B and general entry requirements.

Further information

This course replaces FYST24, Physics: The Physics of Low-dimensional Structures and Quantum Devices, 7.5 credits, and cannot be included in degree together with this course.

Knowledge of FYSN27 Physics: Quantum Mechanics, 7.5 credits, is recommended but is not a requirement.

The course is coordinated with FFFN35, The Physics of Low-dimensional Structures and Quantum Devices, 7.5 credits that is a course given at Lund Institute of Technology, LTH.

The examination of the course is scheduled in accordance with the LTH exam schedule.

The course is offered at the Department of Physics, Lund University.

Subcourses in FYST79, Physics: The Physics of Low-dimensional Structures and Quantum Devices

Applies from H23

2301 Project, 2,0 hp
Grading scale: Fail, Pass
2302 Laboratory Exercises, 1,5 hp
Grading scale: Fail, Pass
2303 Written examination, 4,0 hp
Grading scale: Fail, Pass, Pass with distinction