Course syllabus

Fysik - Kvantfenomen och nanoteknologi
Physics - Quantum Phenomena and Nanotechnology

FAFA10, 9 credits, G1 (First Cycle)

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

General Information

Main field: Technology.
Compulsory for: N2
Elective for: E4
Language of instruction: The course will be given in Swedish

Aim

The objective of the course is to give an introduction to quantum mechanics and its concepts. Furthermore, nanotechnology is introduced as the science of materials and devices whose structure on the nanometre scale has been deigned to give new, unique properties. In order to understand these characteristic properties, quantum mechanics is a necessary tool. Conversely, the course will use nanotechnology to illustrate quantum mechanical phenomena and to motivate for further studies in quantum mechanics. The course will in this way emphasize the mutual interdependence of technology and science in general and of nanotechnology and quantum mechanics in particular. The course should also give the opportunity to reflect on the fascinating phenomena of quantum physics.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- be able to identify and analyse quantum mechanical problems, as well as perform and interpret calculations
- be able to analyse simple problems in nano-physics
- be able to propose hypotheses that can be experimentally tested
- to write simple computer programmes to solve numerical problems

Competences and skills
For a passing grade the student must

- be able to test hypotheses with experiments
- be able to evaluate the results from laboratory work and design simple experiments
- be able to give a short oral presentation
- be able to write a report about a project/laboratory work

Judgement and approach
For a passing grade the student must

- be able to actively participate in a discussion concerning physics problems
- comprehend the possibilities and limitations when using computers to solve applied problems

Contents

A major focus will be on the understanding of basic concepts. The student will be encouraged to actively discuss, explain and reflect on the course content. Lab exercises are exploited to visualise and concretise abstract concepts. This gives the student the possibility to directly observe quantum mechanical phenomena through optical and electrical measurements on materials and devices relevant to optical communication and high-speed electronics. The course also contains an introduction to using computers as calculation tools as well as a larger computational task addressing a quantum mechanical problem.

Introduction to quantum mechanics: Basic concepts such as de Broglie waves, interpretation as probabilities and tunnelling. The Schrödinger equation and energy quantisation in small systems. Absorption and emission of photons in a quantum mechanical picture.

Examination details

Grading scale: UG - (U,G) - (Fail, Pass)
Assessment: The examination is based on a written examination after about 3 weeks, laboratory exercises and projects with written and oral reports. The students have to pass the written examination to be allowed to participate in the laboratory exercises.

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: 0116. **Name:** Quantum Mechanics with Knowledge Assessment.
Credits: 3. **Grading scale:** UG. **Assessment:** Passed knowledge assessment.
Code: 0216. **Name:** Introduction to Matlab with Computer Project.
Credits: 4. **Grading scale:** UG. **Assessment:** Passed home assignments and oral presentation of computer project.
Code: 0316. **Name:** Laboratory Exercises.
Credits: 2. **Grading scale:** UG. **Assessment:** Passed individual laboration reports.

Admission

Assumed prior knowledge: Basic courses in mathematics and programming.
The number of participants is limited to: No
The course overlaps following course/s: FAF240, FAFA55, FAF220

Reading list

- Gunnar Ohlén: Kvantvärldens fenomen, teori och begrepp. Studentlitteratur, 2005, ISBN: 91-44-03450-4.
- Lecture notes.

Contact and other information

Course coordinator: Dan Hessman, dan.hessman@ftf.lth.se
Course homepage: https://canvas.education.lu.se
Further information: Some elements may be taught and assessed in English. This includes a maximum of 1.5 hp, in the form of laboratory sessions or written assignments.