LUNDS UNIVERSITET
Lunds Tekniska Högskola

Course syllabus

Kvantfysikaliska koncept
Concepts in Quantum Physics

FAFA56, 10 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: F1
Language of instruction: The course will be given in Swedish

Aim

Quantum mechanics is a theory that forms the foundation of all modern physics. Quantum physics also covers phenomena and ideas that are entirely different from classical (Newtonian) physics. The aim of this class is to give an introduction to quantum physics and its ideas, and to show examples of how quantum physics is used in modern technology. The intention is to the show the central roll that new, fundamental physics plays in modern technological developments, and to motivate for continued studies. The couse also provides an opportunity to reflect about the different and fascinating world of ideas in quantum mechanics.

For most course participants, this will be the first physics course at the university. A second central aim is therefore to introduce study and working techniques for continued studies.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- be able to describe and interpret foundational discoveries and experiments in quantum physics

- be able to analyze simple problems related to quantum mechanical phenomena
- be able to perform and interpret simple calculations related to problems in quantum physics
- be able to describe and exemplify how modern technology uses quantum physical concepts.
- be able to understand how mathematical models, analogies and pictures interact with experiments and reality.

Competences and skills
For a passing grade the student must

- be able to correctly and completely account for solutions to problems
- be able to test hypotheses by experiments
- be able to design, perform, and analyze simple experiments
- be able to write complete lab reports.
- be able to give correct references to scientific sources.

Judgement and approach
For a passing grade the student must

- be able to actively participate in discussions about physical problems
- be able to work in a larger group for the execution of a project
- be able to identify their own needs for further learning within the area of knowledge, and suggest where to find the information needed.

Contents

Much emphasis will be placed upon concepts and terminology, and on the ability to interpret simple equations in terms of physical concepts and vice versa. Lab exercises will be used to visualize and illustrate abstract concepts. In this way, students get the opportunity to directly observe quantum mechanical phenomena by electrical and optical measurements on materials and devices relevant to optical communication and high speed electronics. Additionally, students will have a laboratory session in problem solving techniques and experimental methodology as well as the handling, analysis and presentation of measurement data.

- Foundational discoveries and experiments in quantum physics: photoelectric effect, Compton effect, interference effects
- De Broglie waves
- Bound states: wave picture and boundary conditions
- Probability interpretation and tunneling
- Uncertainty relationship
- Semiconductor heterostructures
- Quantum phenomena in electronics and optics
- Cryptology and non-local phenomena
- Optical cooling (ultracold atoms)

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)

Assessment: A passing grade requires a passing grade on the written exam as well as approved assignments, project and labs with written and oral presentations, including approved exercise on plagiarism.

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: 0123. **Name:** Laboratory Exercises and Project.
Credits: 4. **Grading scale:** UG. **Assessment:** Passed laboratory exercises and project
Code: 0223. **Name:** Written Exam and Home Assignments.
Credits: 6. **Grading scale:** TH. **Assessment:** Passed written exam and passed home assignments

Admission

Assumed prior knowledge: FMAA05 Calculus in one variable (studied in parallel)
The number of participants is limited to: No
The course overlaps following course/s: FAF220, FAFA05, FAFA50, FAFA10, FAFA55

Reading list

- Gunnar Ohlén: Kvantvärldens fenomen – teori och begrepp. Studentlitteratur. Compulsory course material.
- Halliday/Resnick/Krane: Concepts in Quantum Physics , Kvantfysikaliska koncept, Lunds universitet. Wiley. Custom print for our course with exactly the material we need.
- Chad Orzel: How to Teach Quantum Physics to Your Dog. Oneworld, Oxford. Optional reading.

Contact and other information

Course coordinator: Ville Maisi, ville.maisi@ftf.lth.se
Course coordinator: Adam Burke, adam.burke@ftf.lth.se
Course homepage: https://canvas.education.lu.se/courses/
Further information: It is mandatory to attend the first lecture in order to be admitted to the course. Some elements may be taught and assessed in English. This includes a maximum of 2.5 hp, in the form of laboratory sessions or written assignments.