LUNDS UNIVERSITET
Lunds Tekniska Högskola

Course syllabus

Kvantmekanik, allmän kurs
Quantum Mechanics, General Course

FMFF40, 4 credits, G2 (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: F3
Language of instruction: The course will be given in Swedish

Aim

After completing the course, the student must have sufficient knowledge of quantum mechanics to be able to continue studies in physics.

The course is an important part of a larger course package in physics where, based on quantum mechanics, basic atomic and nuclear physics as well as technical applications are treated. The course will provide an orientation on microcosm and quantum physics, but at the same time do "deep dives" within some selected sub-areas. Partly to practice quantum mechanical problem solving and partly to arouse interest in further studies in the fields.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- Be able to account for and explain the basic postulates of quantum mechanics.
- Be able to explain basic theoretical concepts and models in quantum mechanics and account for which mathematical concepts and methods are used to describe these.
- Be able to exemplify, analyze and problematize the use of basic quantum mechanical models to describe simpler systems in physics such as the hydrogen atom.

- Be able to describe the most important special mathematical functions with application in basic quantum physics.
- Be able to perform certain quantum mechanical calculations on systems with spherical symmetry be able to explain and, in simpler cases, quantitatively calculate the energy structure of an atom using quantum mechanical methods.

Competences and skills
For a passing grade the student must

- Be able to formulate and solve simple quantum mechanical problems relevant to the areas of atomic, nuclear and nanophysics and be able to assess the reasonableness of the solution.
- Be able to apply the course's mathematical methods to selected problems in quantum mechanics.
- Be able, using the course's mathematical methods, to carry out a computer lab and analyze and present the results in written form.

Contents

The formalism of quantum mechanics, more in-depth compared to previous courses. Harmonic oscillator. Spherical symmetry and momentum. Hydrogen-like atoms. Approximate methods. Calculations on problems in atomic and nuclear physics. Spin and multiparticle systems.

Quantum Mechanics: The formalism of quantum mechanics: The Schrödinger equation as an eigenvalue equation. Hermite operators represent physical quantities, eigenvalues and eigenfunctions. Harmonic oscillator.

Calculation methods: First order perturbation theory, energy minimization method, and matrix diagonalization. Spherical coordinates and momentum. Applications on the hydrogen atom and atomic structure. Spin.

Mathematical Methods: Partial differential equations — classification and boundary conditions. General about eigenfunctions to operators. Bessel functions. Legender polynomials. Spherical harmonics.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: Written exam, passed laboratory work and corresponding written reports.

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: 0122. **Name:** Computer Laboratory Work.
Credits: 0,5. **Grading scale:** UG. **Assessment:** Approved written laboratory report after each laboratory exercise. **Contents:** Computer calculations as laboratory exercises in small groups. Preparation before and reporting after

each exercise is mandatory.
Code: 0222. **Name:** Quantum Formalism.
Credits: 3,5. **Grading scale:** TH. **Assessment:** Written examination.

Admission

Assumed prior knowledge: FMAN55 Applied Mathematics, FAFA55 Concepts in Quantum Physics.
The number of participants is limited to: No
The course overlaps following course/s: FMFF15

Reading list

- Ohlén, G: Kvantvärldens fenomen - teori och begrepp. Studentlitteratur 2005.

Contact and other information

Course coordinator: Gillis Carlsson, gillis.carlsson@matfys.lth.se
Course homepage: https://www.matfys.lu.se/education/undergraduate-courses/kvantmekanik/
Further information: Some elements may be taught and assessed in English. This includes a maximum of 1 hp, in the form of laboratory sessions or written assignments.