Faculty of Science

FYSB22, Physics: Basic Quantum Mechanics, 7.5 credits

Fysik: Grundläggande kvantmekanik, 7,5 högskolepoäng

First Cycle / Grundnivå

Details of approval

The syllabus is an old version, approved by Study programmes board, Faculty of Science on 2020-07-02 and was valid from 2020-07-02 , spring semester 2021.

General Information

The course is a compulsory course at first cycle level for a Degree of Bachelor in physics.

Main field of studies	*Depth of study relative to the degree requirements*
Physics	G2F, First cycle, has at least 60 credits in first-cycle course/s as entry requirements

Learning outcomes

The general aim of the course is that students after completed course should have acquired knowledge and skills in the basic quantum mechanics that are needed for continued studies of quantum physics. The course is based on the knowledge described in the course syllabi for the courses: FYSA12, FYSA13, FYSA14, MATA21, MATA22, NUMA01, MATB21 and good knowledge of their all in all contents facilitate for the student to carry out the course. The course FYSB21 is expected to be taken in parallel with this course.

Intended learning outcomes in the programme syllabus refer to the programme syllabus of the Degree of Bachelor in physics at Lund University which corresponds to targets for general qualification in the Higher Education Ordinance in turn.

1 - 4 is interim target against intended learning outcome 1 the programme syllabus.

5 - 9, 11 and 12 is interim target against intended learning outcome 3 in the programme syllabus.

1 and 10 is interim target against intended learning outcome 4 in the programme syllabus.

10 and 11 is interim target against intended learning outcome 5 in the programme syllabus.

13 and 14 is interim target against intended learning outcome 6 in the programme syllabus.

15 is interim target against intended learning outcome 7 in the programme syllabus.

15 and 16 is interim target against intended learning outcome 8 in the programme syllabus.

Knowledge and understanding

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

1. describe the basic properties of quantum particles as well as explain key concepts such as wave-particle duality, wave function and superposition
2. formulate, and qualitatively justify the Schrödinger equation
3. explain and provide examples of how operators in quantum mechanics are used to represent observable physical quantities
4. formulate expressions for a measurement on a quantum particle and explain central concepts as probability, outcome, expectation value and uncertainty.

Competence and skills

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

5. solve the Schrödinger equation for an infinite potential well in one dimension as well as describe the main features of the solution and its properties for a finite well
6. calculate the probability and describe the qualitative properties of transmission through simple potential structures in one dimension
7. derive basic operator relations and perform simple calculations using operators
8. carry out simple approximate calculations of energies based on pertubation theory and variational method
9. formulate the Schrödinger equation for the harmonic oscillator in one dimension in terms of ladder operators, as well as calculate and describe the key properties of wave functions and eigen energies
10. in a small group, carry out experimental laboratory sessions in the subject and present the work in a written laboratory report
11. use numerical methods to solve quantum mechanical problems
12. based on a probability distribution decide different expectation values of individual statistical variables and the sum of several independent variables.

Judgement and approach

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

13. assess in which situations a quantum mechanical method is required.
14. evaluate the importance of statistical uncertainties in quantum mechanics.
15. explain and give examples of the role of quantum mechanics in the societal progress.
16. based on the course learning outcomes and their own goals, reflect on their progress with regard to knowledge and skills.

Course content

The course covers basic quantum mechanics. Specific topics covered:

- wave-particle duality, superposition and wave function
- the Schrödinger equation
- bound states in one dimension

- scattering in one-dimensional potentials
- operators, observables and operator relations
- measurements, expected values and uncertainty
- harmonic oscillator
- approximate methods for the calculation of energies

Course design

The teaching consists of lectures and calculation exercises and laboratory and numerical projects. In addition, optional written assignments give the possibility to bonus point for the examination.

Assessment

The assessment is based on:

- compulsory laboratory and numerical projects and passed reports correspond to 2 credits and mainly assess intended learning outcomes 10 and 11
- a written or oral examination at the end of the course corresponds to 5.5 credits and assess mainly intended learning outcomes 1-9, 11-15.
- compulsory self-reflection mainly assesses intended learning outcome 16.

Students who do not pass an assessment will be offered another opportunity for assessment 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 whole course, participation in all compulsory components, passed reports and approved examination are required:

- introduction meeting
- introduction to the project
- laboratory and numerical projects
- self-reflection on learning

Calculation of grade

- Self-reflection and laboratory and numerical projects only give grade Fail and Pass and not are used to calculate a final grade.
- The examination gives a grade based on the proportion of completed credits. The minimum required for a Pass is normally 50% while the minimum for a Pass with Distinction is 80%.
- When all compulsory components are Pass or Pass with distinction, the grade for the whole course is decided by the examination result.

Entry requirements

Entry to the course requires general entry requirements and 30 credits physics

knowledge equivalent to: FYSA12 15 credits, FYSA13 7.5 credits and FYSA14 7.5 credits, and 45 credits mathematics equivalent: MATA21 15 credits, MATA22 7.5 credits, NUMA01 7.5 credits, MATB21 7.5 credits, MATB22 7.5 credits.

Students who have obtained the equivalent knowledge by other means may also be admitted to the course.

Further information

The course may not be included in a degree together with FYSB11 Physics: Basic quantum mechanics, 7.5 credits.

Subcourses in FYSB22, Physics: Basic Quantum Mechanics

Applies from H23

2301 Examination, 5,5 hp
Grading scale: Fail, Pass, Pass with distinction
2302 Laboratory and numerical projects, 2,0 hp
Grading scale: Fail, Pass

Applies from V21

2101 Examination, 5,5 hp
Grading scale: Fail, Pass, Pass with distinction
2102 Laboratory and numerical projects, 2,0 hp
Grading scale: Fail, Pass