Faculty of Science

FYSA13, Physics: Introduction to University Physics, with Optics, Waves and Quantum Physics, 7.5 credits

Fysik: Introduktion till universitetsfysik, med optik, våglära och kvantfysik, 7,5 högskolepoäng

First Cycle / Grundnivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2019-06-26 and was last revised on 2024-11-06 by The Education Board of Faculty of Science. The revised syllabus comes into effect 2024-11-06 and is valid from the autumn semester 2025.

General information

The course is a compulsory course for first-cycle studies for a Bachelor of Science in physics.

Language of instruction: Swedish and English
The course is given in Swedish during autumn semesters. Occasional components been given, and are assessed in English. It includes no more than 1.5 credits in the form of laboratory sessions or written assignments.

The course is given in full in English during spring semesters.

Main field of study	*Specialisation*
Physics	G1F, First cycle, has less than 60 credits in first-cycle course/s as entry requirements

Learning outcomes

The course intends to give basic knowledge in optics, waves and quantum physics as well as their applications in research and society. The course is included in the basic course for physics. The aim of the course is that the students should have acquired the following knowledge, skills and assessment skills on completion of the course (the references to aims aim on the intended learning outcomes in the programme syllabus of Degree of Bachelor in physics at Lund's university which corresponds to qualitative target for general qualification in the Higher Education Ordinance in turn see "other"):

The aims of the course:
1-10 is interim target against intended learning outcomes 1 in the programme syllabus.
11, 12, 14 and 15 are interim target against intended learning outcomes 2 in the programme syllabus.
11 and 12 is interim target against intended learning outcomes 3 in the programme syllabus.
13 is interim target against intended learning outcomes 4 in the programme syllabus.
13 is interim target against intended learning outcomes 5 in the programme syllabus.
16-19 is interim target against intended learning outcomes 6 in the programme syllabus.
16 is interim target against intended learning outcomes 7 in the programme syllabus.

Knowledge and understanding

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

1. Define what a harmonic oscillation is and how it can be described mathematically.
2. Account for the wave concept and how mechanical waves can be described by the wave function.
3. Describe and explain standing waves.
4. Account for the derivation and the application of physical models for sound waves.
5. Describe and discuss experiments in which light behaves as a wave phenomenon and how these experiments can be described mathematically.
6. Describe and discuss wave-particle duality, quantum quantisation of physical units and the uncertainty principle.
7. Describe and discuss Bohr's model for the hydrogen atom, transitions between quantized states and discrete spectra.
8. Account for the Schrödinger equation in one dimension, wave functions and probability density at a general level.
9. Account for how light is reflected and refracted when it passes between media with different refraction index.
10. Use basic computational principles for geometrical optics and apply these practically to describe for example glasses, microscopes and telescopes.

Competence and skills

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

11. Use the basic concepts and carry out calculations and solve theoretical problems in the part of waves, optics and quantum physics that the course contains.
12. Based on given instructions carry out measurements and carry out laboratory work in optics and spectroscopy.
13. Write an individual written report on the results of laboratory work and calculations.
14. Carry out a simple analysis of experimental results and discuss the uncertainty and the reasonableness in the measured values.
15. Account for how physical models can be derived from basic principles and be tested by experimental measurements.

Judgement and approach

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

16. Use arguments that are based on concept in optics, waves and quantum physics when physical phenomena in society or the everyday life and that lie within the scope of the course material should be described.
17. Argument for why physics is not a description of the laws of nature but that

physics is describing phenomena in nature using physical models (most often mathematical descriptions) .
18. Critically discuss the limitations of the models that are used in the course as well as account for the importance of carrying out experiments to be able to evaluate the reliability of physical theories.
19. Based on wave-particle duality discuss why physical models and physical theories in general provide a limited and approximate description of phenomena in nature.

Course content

The course consist of three parts:

Part 1 Waves 3.5 credits

In this part, basic waves is treated such as periodic harmonic motion, the wave equation, mechanical waves and sound waves. Based on description of the light with wave models, light phenomena such as interference and diffraction are treated. Waves is divided into 3 credits in theory and 0.5 credits laboratory sessions.

Part 2 Quantum Physics 2.0 credits

The waves in part 1 constitutes the basis for subcourse 2 there quantum physical concepts as wave-particle duality, quantum quantisation of physical units and the uncertainty principle are introduced together with Bohr's model for the hydrogen atom, the photoelectric effect and Compton scattering. Here, an introduction is also given to the Schrödinger equation in one dimension that is applied on the infinite potential well. Quantum Physics is divided into 1.5 credits in theory and 0.5 credits laboratory sessions.

Part 3 Optics 2.0 credits

In this part, beam optics, the propagation, reflection and refraction of light, imaging in mirrors, spherical surfaces and lenses and optical instruments are treated. " Optics is divided into 1.5 credits in theory and 0.5 credits laboratory sessions.

In all modules, laboratory activities are an important part.

Course design

The teaching consists of teaching sessions, lectures, written assignments and laboratory sessions. Participation in the laboratory sessions and introductory meetings as well as submission of laboratory reports within given time frames is mandatory.

Assessment

Examination takes place in the form of three written examinations at the end of the course and of mandatory laboratory sessions with reports completed during the course:

- The written examinations assess intended learning outcomes 1-12, 16-18
- The laboratory sessions and written laboratory reports assess intended learning outcomes 13-15

The written examinations together correspond to 6 credits and the laboratory sessions corresponds to 1.5 credits.

Students who do not pass a regular exam are offered a new possibility shortly after the regular exam.

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.

Grades

Grading scale includes the grades: Fail, Pass, Pass with distinction
The laboratory sessions and laboratory reports are graded according to the scale Fail, Pass, while the written exams are graded according to the scale Fail, Pass, Pass with Distinction.

To pass in the whole course is required passed examinations passed laboratory work and laboratory reports as well as participation in all mandatory components.

The written examination results are given as percentages where the limit for receiving grade Pass is 50% and for grade Pass with distinction 80%. For grade Pass with distinction in the course, passed laboratory sessions, laboratory reports and written assignments are required, as well as Pass with distinction on the written examinations. Written assignments can give bonus points to the examination.

Entry requirements

Admission to the course requires knowledge equivalent to FYSA22 Introduction to university physics with mechanics, 7.5 credits and FYSA23 Introduction to university physics with electricity, 7.5 credits.

Further information

The course is part of the Bachelor's program in physics, theoretical physics, astrophysics or of the medical physics program. The teaching is based on the assumption that the student follows the program and has assimilated the knowledge in the previous courses, and takes other program courses in parallel. For those who have acquired equivalent knowledge in other ways, the course can be taken as a stand-alone course.

The course may not be included in qualification together with FYSA01 Physics 1: General Physics, 30 credits as well as ÄFYD01 Physics: General physics with didactics, 30 credits or the equivalent earlier courses.

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

Appendix 1: Aims stated in the programme syllabus of Degree of Bachelor of Science:

Knowledge and understanding
For Degree of Bachelor, the student should:

1. show knowledge and understanding in the main field of study for the education included knowledge of the disciplinary foundation of the field, knowledge of applicable methods in the area, specialisation in some part of the field as well as orientation in current research questions.

Competence and skills
For Degree of Bachelor, the student should:

For Degree of Bachelor, the student should:
2. demonstrate the ability to search, collect, evaluate and interpret relevant information in a problem critically as well as to discuss phenomena critically issues and situations,
3. demonstrate the ability to independently identify, formulate and solve problems as

well as to carry out assignments within given time frames
4. demonstrate the ability to orally and in writing account for and discuss information, problems and solutions in dialogue with different groups and
5. demonstrate the skills required to work independently in the field of the programme

Judgement and approach
For Degree of Bachelor, the student should:

6. demonstrate the ability to in the main field of study for the education make assessments considering relevant scientific, social and ethical aspects
7. demonstrate an understanding of the role of the knowledge in society and if the responsibility of people for how it is used and
8. demonstrate the ability to identify his need of additional knowledge and to develop his skills.?