Faculty of Science

FYSB21, Physics: Mathematical Methods for Vibrations, Waves and Diffusion, 7.5 credits

Fysik: Matematiska metoder för svängningar, vågor och diffusion, 7,5 högskolepoäng

First Cycle / Grundnivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2020-07-02 and was last revised on 2024-11-27 by The Education Board of Faculty of Science. The revised syllabus comes into effect 2024-11-27 and is valid from the spring semester 2025.

General information

The course is elective course in the scientific Bachelor's programme and a compulsory course for a Degree of Bachelor of Science in physics and for the programme in medical physics.

Language of instruction: English

Main field of study	*Specialisation*
Physics	G2F, First cycle, has at least 60 credits in first-cycle course/s as entry requirements

Learning outcomes

The course intends to give the student the opportunity to train the use of mathematical and numerical methods to study problems in mainly classical physics. Especially, the complex Fourier transform and differential equations with applications to different systems are treated. The course is based on top of 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.

Intended learning outcomes in the programme syllabus refer to 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.

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

10 is interim target against intended learning outcomes 2 in the programme syllabus

5, 7, 8 is interim target against intended learning outcomes 3 in the programme syllabus.

9 is interim target against intended learning outcomes 4 in the programme syllabus

6, 7 is interim target against intended learning outcomes 5 in the programme syllabus

11 is interim target against intended learning outcomes 6 in the programme syllabus.

13 is interim target against intended learning outcomes 7 in the programme syllabus.

12, 14 is interim target against intended learning outcomes 8 in the programme syllabus.

Knowledge and understanding

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

1. Explain the physics of the harmonic oscillator in detail.
2. Describe the basic equations for heat conduction and diffusion.
3. Relate phase and group velocity to the concept dispersion.
4. Explain and use different general and partial differential equations that occur in physics.

Competence and skills

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

5. Use the complex Fourier transform in time and space.
6. Analyse electric circuits with a spectrum analyzer.
7. Analyse vibrating systems as eigenvalue problems.
8. Use numerical methods to solve simple differential equations.
9. Discuss his understanding of physical problems in writing.
10. Summarise and collect information from different sources relevant for the course content.

Judgement and approach

After completed the course the student should be able to:

11. Decide and evaluate the usability of complex numbers to solve linear differential equations.
12. Discuss estimate of magnitudes critically to analyse physical problems.
13. Identify and discuss the effect of different gases on the greenhouse effect.
14. Reflect, based on learning objectives and one's own aims, on progress regarding knowledge and skills.

Course content

The course treats:

- Driven harmonic oscillator with Q-factor, phase and line widt
- Complex Fourier transform
- Short introduction to non-linear oscillations
- Sound and water waves
- Mathematical description of wave packets with phase and group velocity
- Vibration modes in molecules, strings and drums.
- Diffusion and heat conduction

Course design

The teaching consists of lectures, calculation exercises, laboratory and numerical projects with written reports. Participation in the projects, submission of reports and written assignments are compulsory.

Assessment

The assessment is based on

- a written examination that corresponds to 4 credits and assess mainly the aims 1-5, 7 and 11.
- compulsory laboratory and numerical projects and passed reports that correspond to 3 credits and that mainly assess the aims 6, 8-10 and 12.
- compulsory written assignments that correspond to 0.5 credits and assess mainly the aims 5, 7 and 13.
- compulsory self-reflection. Assess mainly intended learning outcomes 14.

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.

Grades

Grading scale includes the grades: Fail, Pass, Pass with distinction
To pass the whole course, passed reports and examination are required, and participation in all compulsory components:

- introduction meeting,
- introduction to project,
- laboratory and numerical projects,
- self-reflection over learning.

Calculation of grade

- Self-reflection only gives the grades Failed and Passed, and are not used to calculate a final grade.
- Examination gives a percentage grade that corresponds to the part completed credits, relatively the total number possible credits. The border for Passed is normally 50% and to pass with distinction 80%.
- Laboratory and numerical projects (where implementation and reports are taken into account), and written assignments give the grades Fail, Pass or Pass with distinction. For joining for final course grade, these are converted to percentage grade according to G=65%, VG=90%.

For calculation of final results and grades for the whole course, a weighted mean is used by percentage grade for examination, the projects and and written assignments where the credits for the components are used as weight. The limit for Pass with distinction is 80%.

Entry requirements

Entry to the course requires general entry requirements and 30 credits in mathematics (maximum one of the courses incomplete, but at least followed) including courses equivalent to:

- MATA21 Analysis in One Variable, 15 credits,
- MATA22 Linear Algebra 1, 7.5 credits, and
- NUMA01 Computational Programming with Python, 7.5 credits,

and an additional 15 credits in mathematics (at least taken) including courses equivalent to:

- MATB21 Analysis in Several Variables 1, 7.5 credits, and
- MATB22 Linear Algebra 2, 7.5 credits,

and 30 credits in physics (maximum one of the courses incomplete, but at least followed) including courses equivalent to:

- FYSA22 Introduction to University Physics, with Mechanics, 7.5 credits
- FYSA23 Introduction to University Physics, with Electricity, 7.5 credits
- FYSA13 Introduction to University Physics, with Optics, Waves and Quantum Physics, 7.5 credits and
- FYSA14 Introduction to University Physics, with Thermodynamics, Climate and Experimental Methodology, 7.5 credits.

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

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 is given by the Department of Physics, Lund University.