Details of approval

General Information
The course is an elective component of the Bachelor’s programs in science, and a compulsory component of a Bachelor of Science degree in Physics and of the Master of Science program in Medical Physics.

Language of instruction: English

Main field of studies            Depth of study relative to the degree requirements
Physics                           G2, first cycle

Learning outcomes
The course trains the use of mathematical and computational techniques for studying problems in classical physics. Particular emphasis is given on the complex Fourier transformation and differential equations, which are used in several contexts.

Knowledge and understanding
On completion of the course, the students shall be able to:
1) explain the general behavior of the driven harmonic oscillator in detail [1]
2) reproduce the basic equations describing heat conduction and diffusion [1]
3) relate phase and group velocity to dispersion [1]
4) account for different ordinary and partial differential equations appearing in physics [1]

Competence and skills
On completion of the course, the students shall be able to:
1) apply complex Fourier-transformations in time and space [3]
2) analyze electrical circuits with a signal analyzer [5]
3) study vibrating systems as an eigenvalue problem [3,5]
4) apply numerical tools to solve simple differential equations [3]
5) document their understanding of physical problems in written text [4]
6) collect information from different sources [2]

Judgment and approach
On completion of the course, the students shall be able to:
1) review the applicability of complex numbers for linear differential equations [6]
2) critically discuss estimations of magnitude for physical problems [8]
3) assess the relevance of different gases for the greenhouse effect on the basis of their vibrational modes [7]

Course content
- Driven harmonic oscillator with Q-factor, phase and linewidth
- Complex Fourier transformation
- A brief introduction to nonlinear oscillations
- Physics of sound and water waves
- Mathematical description of wavepackets with phase and group velocity
- Vibrational modes of molecules, strings, and drum
- Diffusion and heat conduction

**Course design**
Teaching consists of lectures, homework exercises, and laboratory exercises. The participation in laboratory exercises and the handing-in of homework exercises as well as lab-reports are compulsory.

**Assessment**
The assessment is based on the written exam at the end of the course and through participation in compulsory components.
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**
The grading scale is Fail / Pass / Pass with distinction.
For a grade of Pass on the whole course, the student must have passed the exam and the lab reports.
The final grade is determined by weighting the grades of the exam (50%), the grades on the Lab reports (20% each) and the homework exercises (10% in total), where an internal percentage scale is applied for each moment to determine the total result.

**Entry requirements**
To be admitted to the course, students must meet the general entry requirements for physics and have finished 22.5 hp out of the following physics courses: FYSA12, FYSA13, FYSA14 or equivalent. 22.5 hp of finished mathematics courses out of the following courses or equivalent is also a requirement for admission to the course: MATA21, MATA22, NUMA01, MATB21, and MATB22
The course builds on knowledge defined in the syllabus of the following courses: FYSA12, FYSA13, FYSA14, MATA21, MATA22, NUMA01, MATB21, MATB22, and students are expected to know and understand this.
**EXTRA MATERIAL, ILLUSTRATING THE REALIZATION OF THE COURSE PLAN**

This explains how the learning outcomes are assessed (highlighted in red)  
K,C,J refers to knowledge, competence and judgment above

**Week 1-3: Complex signal in time and ordinary differential equations**
- Intro to complex numbers and Euler’s formula
- Examples for damped oscillator and treatment with complex x(t)
- Driven oscillator, Delta function, maybe Green’s function(superficial)
- Fourier-analysis in time of general signals, resonance width use FFT with Python
- Some nonlinear oscillation, maybe Runge-Kutta with Python.
- HOMEWORK EXERCISE with a Fourier transformation and an oscillator problem  
  K1, C1
- LAB on signal analyzer. Preparatory self study of LCR circuit.  
  C2,5,6 (In weeks 3-4)

**Week 4-7: Waves and partial differential equations**
- Diffusion as partial differential equation
- Fourier-analysis in time and space, solving the diffusion equation
- LAB on simulation of a heat-conduction problem with Python. Preparatory self study on  
  heat conduction with a specific question to quantify a topic at choice.  
  C4,5,6, J3 (In weeks 5-6)
- Oscillation modes of composed systems (CO2 molecule, string, drum) and their  
  mathematical treatment as eigenvalue problems. Content of Sturm-Liouville theorem  
  (without detailed proof)
- HOMEWORK EXERCISE with a discrete and a continuous eigenvalue problem  
  C3
- Physics of sound and water waves
- wave packets, dispersion, group velocity

**Several exercises** with simple problems and inserting numbers, training K1-4, C1, C3, J1-3  
**Exam:** K1-4, J1,2, one larger problem from C1 or C3