Details of approval

General Information
The course is a compulsory second cycle component of a Bachelor degree in Physics, Theoretical Physics and ?? Which directions need to be included? Language of instruction: English

Main field of studies Physics

Depth of study relative to the degree requirements G2, second cycle

(if 60 credits are appropriate it is G2 -- at the end of the mall 90 credits are required, then it would be first-cycle????)

Learning outcomes
The course shall train 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
2) reproduce the basic equations describing heat conduction and diffusion
3) relate phase and group velocity to dispersion
4) account for different ordinary and partial differential equations appearing in physics

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

Judgement and approach
On completion of the course, the students shall be able to:
1) assess the relevance of different gases for the Greenhouse effect
2) review the applicability of complex numbers for linear differential equations
3) critically discuss estimations of magnitude for physical problems

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, exercises, and laboratory exercises. Participation in laboratory exercises is compulsory. Handing-in of homework exercises and lab-reports is 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, lab reports and compulsory components.
The final grade is determined by weighting the grades of the exam (60%) and the grades on the Lab reports (20% each), 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 have 60 ECTS credits in Natural Science studies, including knowledge corresponding to NUMA01 Calculation Programming with Python, 7.5 credits, MATB21 Multivariable 1, 7.5 credits and MATB22 Linear Algebra 2, 7.5 credits. (Did I get this right? We require knowledge, but the student may have failed the exam in some of them. The course should come after the Math block, parallel with FYSB11 Quantum Mechanics)

Underlying idea and assessment (K,C,J refers to knowledge, competence and judgement 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, maybe FFT with Python?
- Some nonlinear oscillation, maybe Runge-Kutta with Python? In Computer-Exercise?
- Homework exercise with a Fourier transformation and an oscillator problem C1
- LAB on signal analyzer. Preparatory self study of LCR circuit. C2,5,6

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
- 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 an 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