DEPARTMENT OF PHYSICS

FYM330 Computational continuum physics, 7.5 credits

Beräkningsmetoder för kontinuumfysik, 7,5 högskolepoäng

Second Cycle

Confirmation

This course syllabus was confirmed by Department of Physics on 2019-11-04 and was last revised on 2023-05-08 to be valid from 2024-01-15, spring semester of 2024.

Field of education: Science 100%
Department: Department of Physics

Position in the educational system

The course is elective within the master program in physics.

The course can be part of the following programmes: 1) Complex Adaptive Systems, Master's Programme (N2CAS) and 2) Physics, Master's Programme (N2PHY)

Main field of studies	*Specialization*
Physics	A1N, Second cycle, has only first-cycle course/s as entry requirements

Entry requirements

A Bachelor's degree in physics or equivalent, including 30 credits mathematics (including linear algebra and analysis), and programming.

Prior knowledge in computational physics and numerical analysis through advanced level courses is recommended.

Applicants must prove their knowledge of English: English 6/English B from Swedish Upper Secondary School or the equivalent level of an internationally recognized test, for example TOEFL, IELTS.

Learning outcomes

The aim of the course is to outline modern computational methods to describe the properties and dynamics of continuum systems, such as fluids and gases, electromagnetic fields, and plasmas. The aim is furthermore to exemplify how such methods can be used to calculate the properties of such systems, of importance for a wide range of applications. Furthermore, the course provides a tool box for computational physics applicable to a broad set of problems, of in-terest both in basic and applied research and development. The course provides practice in using Python, C and elements of C++ for solving problems of computa-tional physics.

On successful completion of the course the student will be able to:

· Able to construct discretize equations governing a physical process with respect to the variables involved
· Explain basic time-integration methods
· Explain how to implement initial and boundary conditions
· Explain how to solve stationary problems, such as the Poisson equation
· Explain how to solve such equations in a reliable manner
· Explain how to treat multi-physics problems
· Able to discuss common computational methods and tools in computational continuum systems
· Use methods such as finite-difference time-domain, finite-element, plane-wave expansion, methods of moments
· Use methods such as finite-volume, spectral, pseudo-spectral
· Use methods such as CFL condition, explicit and implicit integration, operator splitting, geometric integration, stability preserving integration schemes
· Identifying and mitigating numerical artefacts and effects.
· Identify and explain conservation properties, such as particle number/mass conservation, energy conservation, phase-space incompressibility, positivity preserving schemes, and know how to test schemes for conservation properties
· Identify and evaluate classical test problems, checking convergence properties, method of manufactured solutions
· Write technical reports where computational results are presented and explained
· Communicate results and conclusions in a clear way.

Course content

· Finite difference and related techniques.
· Spectral methods.
· Examples of continuum systems.
· Practice in using Python, C and elements of C++ as a programming tool.

Form of teaching

Basic theory and methods are covered by a series of lectures. The students get training by applying the theory and methods in exercises and homework prob-lems. An important part consists of practical training of carrying out computa-tions using a set of given problems within projects throughout the course. The projects are accounted for in a written report. It is expected that the projects normally are performed in teams of two.

Language of instruction: English

Assessment

The course contains coding assignments, computing-lab assignments, theory assignments contained within projects worked on throughout the course. The examination is through a hand-in report at the end of the course. All examina-tion parts will be graded in order to achieve the final grade.

If a student, who has failed the same examined element on two occasions, wishes to change examiner before the next examination session, such a request is to be submitted to the department in writing and granted unless there are special reasons to the contrary (Chapter 6, Section 22 of Higher Education Ordinance).

In the event that a course has ceased or undergone major changes, students are to be guaranteed at least three examination sessions (including the ordinary examination session) over a period of at least one year, though at most two years after the course has ceased/been changed. The same applies to work experience and VFU, although this is restricted to just one additional examination session.

Grades

The grading scale comprises: Pass with Distinction (VG), Pass (G) and Fail (U).

Course evaluation

The results of and possible changes to the course will be shared with students who participated in the evaluation and students who are starting the course.