Faculty of Science

FYTN03, Theoretical Physics: Computational Physics, 7.5 credits

Teoretisk fysik: Beräkningsfysik, 7,5 högskolepoäng

Second Cycle / Avancerad nivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2009-09-11 to be valid from 2009-09-11, spring semester 2010.

General Information

The course is for second-cycle studies for a Degree of Master of Science (120 credits) with a specialisation in physics.

Language of instruction: English and Swedish
If needed, the course is given in English in its entirety.

Main field of studies	*Depth of study relative to the degree requirements*
Physics	A1N, Second cycle, has only first-cycle course/s as entry requirements

Learning outcomes

The purpose of the course is to provide the student with practical and theoretical knowledge of some commonly used methods for numerical calculations in physics.

The aims of the course are that, upon completion of the course, the student should have acquired the following knowledge and skills:

- Programming: The student can write programs in C to solve simple physical problems. The student can modify larger, more complicated programs in C or C++ to solve more complicated problems.
- Linear Algebra: The student understands how to use an external program package for linear algebra to perform simple vector and matrix operations, such as to invert matrices and solve systems of linear equations.
- Error estimation, interpolation and extrapolation: The student understands and can estimate the different errors that arise in numerical calculations. The student can use Lagrange's formula for interpolation. The student can derive and use

Richardson´s formula for extrapolation. The student has heard of cubic splines and other methods for interpolation.
- Numerical integration: The student understands and can use the trapezoidal rule and Gaussian quadrature for integration.
- Random numbers: The student is familiar with general properties of random numbers and can derive the central limit theorem. The student can also transform random numbers generated according to an arbitrary distribution to another one.

- Monte Carlo: The student can derive and use Monte Carlo integration for simple physical systems with many degrees of freedom. The student understands and can use the Metropolis algorithm.
- Optimisation and minimizing: The student understands and can use conjugate gradient methods. The student is aware of problems that can arise when optimising/minimizing functions with bounadary constraints. The student can account for the basis of simulated cooling.
- Ordinary Differential Equations: The student can derive and use the Runge-Kutta method. The student can describe how one analyses the stability of a numerical solution to a simple ordinary differential equation. The student can describe how one can integrate the equations of motion for simple systems.
- Partial Differential Equations: The student can describe how to numerically solve diffusion- and wave equations, and explain how the method of relaxation is applied for Poisson's equation.

Examples of problems that the student should be able to solve upon completion of the course:

- Given a function with a given approximate form in a given number of dimensions, decide which method is appropriate to use to numerically integrate it in a given interval.
- For a given minimizing problem for a function with a given approximate form within a given boundary in a given number of dimensions, decide which minimizing method is appropriate.
- Given a differential equation, analyse possible stability problems and decide which numerical method that is most suitable.

Course content

The course consists of the elements described above for a total of 7.5 credits.

Course design

The teaching consists of computer exercises, lectures and exercises. Participation in the computer exercises is compulsory.

Assessment

The examination consists of written reports on the projects and a written exam at the end of the course. Students who do not pass the regular exam are offered a re-examination in close connection to the regular exam.

Subcourses that are part of this course can be found in an appendix at the end of this document.

Grades

Marking scale: Fail, Pass, Pass with distinction.
To pass the entire course, it is required to pass both the written exam and the projects reports as well as participation in all compulsory elements. The final grade is determined by the results of the different parts of the examination.

Entry requirements

The prerequisites required for admission to the course are: English B and general entry requirements as well as knowledge equivalent to 90 credits in physics and 30 credits in mathematics.

Further information

The course may not be credited towards a degree together with FYSM01 Physics 4, Introduction to advanced studies in physics, if this includes FYTN03 as a module.

Subcourses in FYTN03, Theoretical Physics: Computational Physics

Applies from H13

1301 Project, 4,5 hp
Grading scale: Fail, Pass, Pass with distinction
1302 Theory Examination, 3,0 hp
Grading scale: Fail, Pass, Pass with distinction

Applies from H07

0701 Computational Physics, 7,5 hp
Grading scale: Fail, Pass, Pass with distinction