Computer simulation of physical processes

Curriculum

Numerical algorithms for solving ordinary equation systems and partial differential equations. Stiff systems.
The concept of chaotic motion, butterfly-effect, bifurcations, fractals. Tools and methods to investigate continuous-time deterministic and chaotic systems. Phase space, stroboscopic map, Lyapunov exponent, Fourier analysis.

Mechanical two- and three-body problem. Harmonic and anharmonic oscillator. Heat conduction and diffusion. Linear and nonlinear RLC circuits, ferroresonance. Waves in linear and nonlinear media.

Requirements

At the first part of the semester, students write short computer codes in a language chosen by them to practice what they learned, from the simplest tasks to the more difficult ones. At the second part of the semester, they independently solve a more complex problem by writing a code or using a (commercial) software, like MapleSim. If the student present the solution until the end of the semester and answers the lecturer's questions, he or she obtain the mark.

Required/recommended literature

1. Hoppensteadt, F. C.: Analysis and Simulation of Chaotic Systems, Springer, 2000

2. Braun M., Differential Equations and Their Applications, Springer-Verlag, 1975

3. Singh, V. P.: System Modelling and Simulation, New Age International Publishers, 2009., Chapter 5.

4. Steven C. Chapra, Raymond P. Canale: Numerical Methods for Engineers, McGraw-Hill, 2015.