Computational Methods for Ordinary and Partial Differential Equations

Programme course

6 credits

Beräkningsmetoder för ordinära och partiella differentialekvationer

TANA31

Valid from: 2017 Spring semester

Determined by
Board of Studies for Electrical Engineering, Physics and Mathematics

Date determined
2017-01-25

Main field of study
Mathematics, Applied Mathematics

Course level
Second cycle

Advancement level
A1X

Course offered for
- Applied Physics and Electrical Engineering, M Sc in Engineering
- Mechanical Engineering, M Sc in Engineering
- Mathematics, Master's programme
- Applied Physics and Electrical Engineering - International, M Sc in Engineering

Entry requirements
Note: Admission requirements for non-programme students usually also include admission requirements for the programme and threshold requirements for progression within the programme, or corresponding.

Prerequisites
Calculus in several variables, Linear algebra and some skills in programming.

Intended learning outcomes

Many important problems from technology, science and economics are formulated in terms of differential equations. Thus it is important to be able to solve such equations accurately and efficiently. In the course we treat finite difference approximations of partial differential equations and numerical methods for solving ordinary differential equations. The theory is illustrated by using problems from relevant applications.
After a completed course the student should be able to

- discuss important concepts
- derive difference approximations of derivatives with desired properties and explain how boundary conditions should be treated numerically.
- explain and use standard methods, in particular Runge-Kutta type methods, for solving time dependent problems.
- explain what stiffness is and use implicit time stepping methods for solving stiff problems.
- explain the requirements on the computational mesh that need to be fulfilled in order for a finite difference solution to give a good solution.
- write Matlab programs that solves different types of partial differential equations.
- judge the quality of a numerical solution

Course content

Classification of differential equations, order of accuracy, consistency, convergence, wellposedness, stability, stability analysis using the Fourier ansatz.
Ordinary differential equations: Runge-Kutta methods, explicit and implicit methods, stiff problems.
Partial differential equations: finite difference methods, interpolation of boundary conditions, Crank-Nicholson method.

Teaching and working methods

Lectures, lessons and computer exercises.

Examination

LAB1	Laboratory work	2 credits	U, G
TEN1	Written examination	4 credits	U, 3, 4, 5

The first three course aims are examined with TEN1. The fourth and fifth are examined with LAB1.

Grades

Four-grade scale, LiU, U, 3, 4, 5

Department
Matematiska institutionen

Director of Studies or equivalent
Ingegerd Skoglund

Examiner
Fredrik Berntsson

Course website and other links
http://courses.mai.liu.se/GU/TANA31

Education components
Preliminary scheduled hours: 50 h
Recommended self-study hours: 110 h

Course literature

Additional literature

Books

Bertil Gustafsson, (2008) *High Order Difference Methods for Time Dependent PDE*

Common rules

Regulations (apply to LiU in its entirety)

The university is a government agency whose operations are regulated by legislation and ordinances, which include the Higher Education Act and the Higher Education Ordinance. In addition to legislation and ordinances, operations are subject to several policy documents. The Linköping University rule book collects currently valid decisions of a regulatory nature taken by the university board, the vice-chancellor and faculty/department boards.

LiU's rule book for education at first-cycle and second-cycle levels is available at http://styrdokument.liu.se/Regelsamling/Innehall/Utbildning_pa_grund-_och_avancerad_niva.