SF1682 Analytical and Numerical Methods for Differential Equations 11.0 credits

Analytiska och numeriska metoder för differentialekvationer

This is a translation of the Swedish, legally binding, course syllabus.

Establishment

Course syllabus for SF1682 valid from Autumn 2017

Grading scale

A, B, C, D, E, FX, F

Education cycle

First cycle

Main field of study

Technology

Specific prerequisites

SF1675 Applied Linear Algebra, SF1668 Mathematical and Numerical Analysis I, SF1626 Calculus in Several Variable.

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

After completing the course students should for a passing grade be able to

- select the appropriate method of calculation, and compute solutions to linear differential equations and linear systems of differential equations with constant coefficients, separable, as well as linear differential equations of the first order,
- describe the structure of the solution set of ordinary differential equations and systems of linear ordinary differential equations,
- perform analytical calculations with generalized functions,
- apply the method of variation of parameters, when relevant,
- calculate Laplace transforms and the inverse transform of functions and generalized functions based on the general properties of the Laplace transform,
- calculate Fourier transforms and the inverse transform of functions and generalized functions based on the general properties of the Fourier transform,
- calculate Fourier coefficients of periodic functions and periodic generalized functions based on the general properties Fourier series,
- analyze the stability conditions of autonomous linear systems of differential equations,
- apply transform methods to problems that pertain to engineering,
- apply the method of separation of variables and knowledge of Fourier series to solve partial differential equations,
- assess the reasonableness of a calculated result,
- formulate and use basic numerical methods for differential equations, and demonstrate an understanding of the concepts of convergence and stability,
- implement numerical methods in appropriate programming language (e.g. Matlab) to solve differential equations, and assess the reliability and parameter sensitivity of the numerical solution,
- analyze computational work and accuracy of basic computational problems,
- solve non-linear equations using numerical methods,
- choose appropriate numerical method for the treatment of a given mathematical model and motivate the choice of method by outlining the benefits and limitations,
- solve differential equations with periodic boundary conditions and numerical spectral method and the fast Fourier transform (FFT).

For higher grades, the student in addition should be able

- to some extent be able to modify and combine the methods in the course to new situations,
- be able to create mathematical models - especially with the help of differential equations - for problems that pertain to engineering.

Course contents

- First order ordinary differential equations: Fundamental theory and concepts. Modeling. Direction fields and solution curves. Autonomous equations, stationary solutions and their stability. Separable equations. Linear equations.
- Linear ordinary differential equations of higher order: Basic theory. Methods of solving equations with constant coefficients. Oscillation phenomena.
- Systems of linear ordinary differential equations: Basic concepts and theory. Solution of linear systems with constant coefficients using the eigenvalue method (homogeneous systems) and variation of parameters (partikulärlösningar to inhomogeneous systems).
- Modeling: Laplace transform with applications.
- Fourier series and transforms with applications.
- Linear partial differential equations: Separation of variables. Solution of classical boundary value problems (wave equation, heat equation, Laplace equation) with transform methods.
- Basic techniques of numerical methods, iteration, linearization, discretization and extrapolation, and theoretical concepts such as order of accuracy, speed of convergence, complexity, conditional number and stability.
- Numerical methods for solving nonlinear equations.
- Numerical methods for differential equations such as Euler's method, Runge-Kutta methods, backward Euler method and finite difference methods for boundary value problems.
- Numerical methods based on Fourier series of differential equations with periodic boundary conditions. The fast Fourier transform (FFT).

Course literature

The course literature will be announced on the course homepage at least four weeks before the start of the course.

Examination

- INLA - Assignments, 5.0 credits, grading scale: P, F
- TEN1 - Exam, 6.0 credits, grading scale: A, B, C, D, E, FX, F

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

If the course is discontinued, students may request to be examined during the following two academic years.

Other requirements for final grade

Written exam (TEN1, 6 cr) and hand-in problems (INLA, 5 cr).

Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.