LUNDS UNIVERSITET
Lunds Tekniska Högskola

Course syllabus

Numeriska metoder för differentialekvationer
Numerical Methods for Differential Equations

FMNN10, 8 credits, A (Second Cycle)

Valid for: 2023/24
Faculty: Faculty of Engineering, LTH
Decided by: PLED F/Pi
Date of Decision: 2023-04-18

General Information

Main field: Technology.
Compulsory for: F3, Pi3
Elective for: BME4, I4
Language of instruction: The course will be given in English on demand

Aim

The aim of the course is to teach computational methods for solving both ordinary and partial differential equations. This includes the construction, application and analysis of basic computational algorithms for approximate solution on a computer of initial value, boundary value and eigenvalue problems for ordinary differential equations, and for partial differential equations in one space and one time dimension. Independent problem solving using computers is a central part of the course.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- be able to describe the construction of basic numerical methods and algorithms in a logical and well structured manner, using suitable terminology
- be able to discretize ordinary and partial differential equations using finite difference and finite element methods, and to be able to independently implement and apply such algorithms
- be able to independently proceed from observation and interpretation of results to conclusion, and be able to present and account for his or her conclusions on a scientific

basis in free report format.

Competences and skills
For a passing grade the student must

- be able to independently, on a scientific basis, select suitable computational algorithms for given problems
- be able to apply such computational algorithms to problems from applications
- be able to independently evaluate the relevance and accuracy of computational results
- present solutions of problems and numerical results in written form.

Judgement and approach
For a passing grade the student must

- be able to independently evaluate obtained numerical results in relation to the (unknown) solution of the differential equation studied
- be able to independently present results and conclusions of scientifically performed numerical experiments, in written or oral form, with references and other documentation of work carried out in support of their conclusions.

Contents

Methods for time integration: Euler's method, the trapezoidal rule. Multistep methods: Adams' methods, backward differentiation formulae. Explicit and implicit Runge-Kutta methods. Error analysis, stability and convergence. Stiff problems and A-stability. Error control and adaptivity. The Poisson equation: Finite differences and the finite element method. Elliptic, parabolic and hyperbolic problems. Time dependent PDEs: Numerical schemes for the diffusion equation. Introduction to difference methods for conservation laws.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: Written examination and computer projects. The final grade is the grade obtained on the written exam.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Parts
Code: 0122. **Name:** Written Examination.
Credits: 6. **Grading scale:** TH. **Assessment:** Written examination.
Code: 0222. **Name:** Computer Projects.
Credits: 2. **Grading scale:** UG. **Assessment:** For each project, either a written or an oral presentation of the work. The specific form of presentation will be specified for each project at the start of the course. **Contents:** Three computational projects comprising implementation of numerical methods as computer programs, application of those on selected mathematical problems, and analysis of the results.

Admission

Assumed prior knowledge: FMAB20 Linear Algebra, FMAB30 Calculus in Severable Variables, FMAN55 Applied Mathematics.
The number of participants is limited to: No

The course overlaps following course/s: NUMN12, NUMN20, NUMN32, FMN041, FMN050, FMN081, FMN130, FMNF10

Reading list

- Iserles, A: Numerical analysis of differential equations. Cambridge University Press, 2008, ISBN: 978-0521734905.
- Lecture notes.

Contact and other information

Director of studies: Studierektor Anders Holst, Studierektor@math.lth.se
Course administrator: Student Office, expedition@math.lth.se
Teacher: Monika Eisenmann, monika.eisenmann@math.lth.se
Course homepage: https://canvas.education.lu.se/courses/20395