LUNDS UNIVERSITET
Lunds Tekniska Högskola

Course syllabus

Numeriska metoder för differentialekvationer
Numerical Methods for Differential Equations

FMNN10, 8 credits, A (Second Cycle)

Valid for: 2019/20
Decided by: PLED F/Pi
Date of Decision: 2019-03-26

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. Particular emphasis is placed on the students independently authoring project reports based on interpretation and evaluation of the numerical results obtained, with references and other documention in support of the conclusions drawn.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- 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 write a logically well structured report in suitable terminology on the construction of basic numerical methods and algorithms
- be able to independently evaluate obtained numerical results in relation to the (unknown) solution of the differential equation studied
- be able to independently author project reports of scientific character, with references and other documentation of work carried out in support of his or her 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: The grade is based on homework assignments and a 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.

Admission

Required 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: FMN041, FMN050, FMN081, FMN130, FMNF01

Reading list

- Iserles, A: Numerical analysis of differential equations. Cambridge University Press, 2008, ISBN: 978-0521734905.
- Edsberg, L: An Introduction to Modeling and Computation for Differential Equations.

Wiley, 2008, ISBN: 978-0470270851.
- It is enough to read one of the books. Edsberg's book discusses modelling to a higher degree.

Contact and other information

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Course homepage: http://www.maths.lth.se/na/courses/FMNN10