Faculty of Science

NUMN20, Numerical Analysis: Numerical Methods for Differential Equations, 7.5 credits

Numerisk analys: Numeriska metoder för differentialekvationer, 7,5 högskolepoäng

Second Cycle / Avancerad nivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2019-12-04 to be valid from 2019-12-04, autumn semester 2020.

General Information

The course is an elective course for second-cycle studies for a Master of Science degree in mathematics.

Language of instruction: English

Main field of studies	*Depth of study relative to the degree requirements*
Mathematics with specialization in Numerical Analysis	A1F, Second cycle, has second-cycle course/s as entry requirements

Learning outcomes

The overarching goal of the course is that the students on completion of the course should know the basics of numerical analysis for differential equations. This includes the construction, analysis, implementation and application of numerical methods for initial value problems, boundary value problems and different types of partial differential equations.

Knowledge and understanding

After completing the course the student should be able to:

- discretise ordinary and partial differential equations using finite difference and finite element methods and independently implement and apply such algorithms,
- independently proceed from observation and interpretation of results to conclusion, and present and give an account of his or her conclusions on a

scientific basis in a free report format.

Competence and skills

After completing the course the student should be able to:

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

Judgement and approach

After completing the course the student should be able to:

- write, using suitable terminology, a logically well structured report on the construction of basic numerical methods and algorithms,
- independently evaluate obtained numerical results in relation to the (unknown) solution of the differential equation studied,
- independently write project reports of scientific character with references and other documentation of the completed work in support of his/her conclusions.

Course content

The course treats:

- 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.

Course design

The teaching consists of lectures and compulsory computer projects. 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 documentation in support of the conclusions drawn.

Assessment

Examination consists of written computer project reports during the course and a written examination at the end of the course. Students who fail the regular examination are offered a re-examination shortly thereafter.

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.

Subcourses that are part of this course can be found in an appendix at the end of this document.

Grades

Marking scale: Fail, Pass, Pass with distinction.
The grading scale on the computer project reports are Fail and Pass. The grading scale on the written examination are Fail, Pass, Pass with distinction. To pass the entire course, the student has to pass both the written examination and the computer project reports. To pass with distinction, the student additionally has to pass the written examination with distinction.

Entry requirements

Admission to the course requires English 6 and at least 90 credits in mathematics and/or numerical analysis including the course NUMN19 Numerical Approximation, 7.5 credits, or corresponding.

Further information

The course may not be included in a higher education degree together with NUMN12 Numerical Methods for Differential Equations 7.5 credits.

The course is to be studied together with FMNN10 Numerical Methods for Differential Equations, 8 credits, which is coordinated by LTH.

Subcourses in NUMN20, Numerical Analysis: Numerical Methods for Differential Equations

Applies from H20

2001 Written examination, 6,0 hp
Grading scale: Fail, Pass, Pass with distinction
2002 Computer project, 1,5 hp
Grading scale: Fail, Pass