Faculty of Science

NUMN32, 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 is an old version, approved by Study programmes board, Faculty of Science on 2021-12-06 and was valid from 2021-12-06 , autumn semester 2022.

General Information

The course is a compulsory course for second-cycle studies for a Master of Science degree in Mathematics with specialisation in Numerical Analysis.

Main field of studies	*Depth of study relative to the degree requirements*
Mathematics	A1N, Second cycle, has only first-cycle course/s as entry requirements
Mathematics with specialization in Numerical Analysis	A1N, Second cycle, has only first-cycle course/s as entry requirements
Computational Science	A1N, Second cycle, has only first-cycle course/s as entry requirements

Learning outcomes

The overarching goal of the course is that the students on completion of the course should have acquired a thorough knowledge regarding 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,

- logically and with adequate terminology describe the construction of basic numerical methods and 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:

- independently evaluate obtained numerical results in relation to the (unknown) solution of the differential equation studied,
- 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.

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 partial differential equations: numerical schemes for the diffusion equation.
- Introduction to difference methods for conservation laws.

Course design

The teaching consists of lectures and computer projects. Participation in the computer projects is mandatory. Independent problem solving using computers is a central part of the course.

Assessment

Examination consists of a written examination at the end of the course, and presentations of the computer projects during 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 projects 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 projects. To pass with distinction, the student additionally has to pass the written examination with distinction.

Entry requirements

Admission to the course requires English 6/b and at least 90 credits of which at least 45 credits should be in mathematics and/or numerical analysis, including the courses NUMA01 Computational Programming with Python, 7.5 credits, MATB22 Linear Algebra 2, 7.5 credits, and MATB21 Analysis in Several Variables 1, 7,5 credits, or equivalent. In addition to these 45 credits, also one of the courses MATC12 Ordinary Differential Equations I, 7.5 credits, NUMA41 Numerical Analysis, Basic Course, 7.5 credits, and FYSB21 Physics: Mathematical Methods for Vibrations, Waves and Diffusion, 7.5 credits, or equivalent, is required.

Further information

The course may not be included in a higher education degree together with NUMN12 Numerical Methods for Differential Equations 7.5 credits or with NUMN20 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 the Faculty of Engineering. The examination of the course is scheduled in accordance with the examination schedule at the Faculty of Engineering.

Subcourses in NUMN32, Numerical Analysis: Numerical Methods for Differential Equations

Applies from H22

2201 Written Examination, 6,0 hp
Grading scale: Fail, Pass, Pass with distinction
2202 Computer Projects, 1,5 hp
Grading scale: Fail, Pass