Faculty of Science

NUMN24, Numerical Analysis: Finite Volume Methods, 7.5 credits

Numerisk analys: Finita volymmetoder, 7,5 högskolepoäng

Second Cycle / Avancerad nivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2020-05-19 to be valid from 2020-05-19, spring semester 2021.

General Information

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

Language of instruction: English

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

Learning outcomes

The overall goal of the course is to give insight into modern numerical methods for nonlinear conservation laws with a focus on fluid mechanics. Thereby, students will achieve a deeper understanding on how numerical simulations of aeroplanes, wind turbines or the climate system are done and which difficulties can occur.

Knowledge and understanding

After completing the course the student should be able to:

- give an account of mathematical and numerical difficulties arising with nonlinear conservation laws and shock solution,
- explain stability and convergence of finite volume methods,
- explain the importance of conservation for numerical methods for conservation laws.

Competence and skills

After completing the course the student should be able to:

- derive a finite volume method for a general conservation law,
- choose, implement and apply finite volume methods to nonlinear conservation laws,
- interpret numerical stability and accuracy problems arising in simulations,
- analyse and assess the stability of a discretisation for a conservation law,
- integrate knowledge from the various parts of the course to address problems within the framework of the course,
- plan and execute qualified tasks with appropriate methods within given time-frames.

Judgement and approach

After completing the course, the student should be able:

- to critically evaluate and independently apply methods from the course within a project work,
- evaluate their own responsibility for how the subject is used and discuss the subject's possibilities to contribute to a sustainable social development.

Course content

The course covers:

- Hyperbolic conservation laws and their basic properties (weak solutions, weak entropy solutions, shocks)
- Shocks and Riemann problems
- Conservation in numerical methods
- Finite volume methods and their stability
- Higher-order discretisations
- SBP (summation by parts) discretisations and energy estimates
- Simulations of gas dynamics

Course design

The teaching consists of lectures. Assignments and a compulsory final project are included in the course. The assignments are not compulsory, but they are preparatory for the compulsory final project.

Assessment

The examination consists of a written report of the final project and an appurtenant oral examination based on the report. The oral examination is only given to those students who have passed the written report.

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.
To obtain the grade Pass, the student is required to pass the project report and the oral examination. Grading scale on the Project report is Fail and Pass, and the grading scale for the oral examination of the final Project is Fail, Pass and Pass with distinction.

To obtain the grade Pass with distinction it is required in addition that the student demonstrates a good ability to critically and systematically integrate knowledge from the various parts of the course and handle, analyse and assess various questions posed in the project and at the oral examination.

Entry requirements

For admission to the course English 6/B and at least 90 credits in mathematics and numerical analysis are required, including knowledge corresponding to the course NUMN20 Numerical Methods for Differential Equations, 7.5 credits.

Further information

The course may not be included in a higher education qualification together with NUMN14 Finite Volume Methods, 7.5 credits.

Subcourses in NUMN24, Numerical Analysis: Finite Volume Methods

Applies from V21

2101 Written Project Report, 3,5 hp
Grading scale: Fail, Pass

2102 Oral Examination, 4,0 hp
Grading scale: Fail, Pass, Pass with distinction