Faculty of Science

NUMN26, Numerical Analysis: Simulation Tools, 7.5 credits

Numerisk analys: Simuleringsverktyg, 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 2020-07-07 and was valid from 2020-07-07 , spring semester 2021.

General Information

The course is an elective course for second-cycle studies for a Degree of Master of Science (120 credits) in mathematics with a specialisation in numerical analysis.

Main field of studies	*Depth of study relative to the degree requirements*
Computational Science	A1F, Second cycle, has second-cycle course/s as entry requirements
Mathematics	A1F, Second cycle, has second-cycle course/s as entry requirements

Learning outcomes

Simulation techniques is a field which merges experience in modelling with knowledge in Scientific Computing and programming skills. The aim of the course is to give students in a late stage of their university studies the possibility to work, in small teams, with industrially relevant computational problems in connection with the modelling of complex mechanical systems. The overall aim of the course is that the students should acquire in-depth knowledge of numerical methods for ordinary differential equations with discontinuities and / or algebraic constraints, of numerical methods for solving large nonlinear systems of equations, as well as of applications of mathematical methods found at different levels in industrial simulation tools.

Knowledge and understanding

After completing the course the student should be able to:

- independently identify the appropriate numerical method and select the right parameters with regard to set accuracy and efficiency requirements;
- describe the numerical methods used in subject-relevant commercial simulation

tools,
- make evaluations of simulation results for some mechanical sample problems,
- describe structural similarities between different engineering problems that are treated in the course.

Competence and skills
After completing the course the student should be able to:

- independently apply and critically evaluate numerical methods found in industrial software packages in particular for modeling of complex mechanical systems,
- present in writing and orally, with adequate terminology and algorithmically well-structured, an account of mathematical methods presented in the course.

Judgement and approach
After completing the course, the student should be able to:

- assess simulation results, independently select and evaluate simulation methods and act as a consultant in a simulation context.

Course content

The course treats modeling of complex mechanical problems and how these can be solved numerically. In particular the course covers:

- multistage methods and their implementation in SUNDIALS,
- methods for rigid and non-rigid problems,
- high-frequency problems,
- differential-algebraic equations and models with forced conditions,
- differential equations with discontinuities and related model assumptions,
- methods for differential equations with discontinuities and forced conditions.

Course design

The teaching consists of lectures that introduce the theoretical and algorithmic background to three large simulation projects included in the course. The students document their work on the simulation projects during the course through a report and related program code.

Assessment

The examination consists of a written final report and an appurtenant oral presentation of the simulation projects at the end of the course.

Students who do not pass an assessment will be offered another opportunity for assessment soon 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.
To pass the entire course, the student is required to pass the written report and the oral presentation of the simulation projects.

Entry requirements

For admission to the course, English 6 / B and 90 credits in mathematics and numerical analysis including knowledge corresponding to the courses NUMN20 Numerical Methods for Differential Equations, 7.5 credits and NUMA01 Computational Programming with Python, 7.5 credits, are required.

Further information

The course cannot be included in a degree together with the course NUMN05 Simulation tools, 7.5 credits.

The course is to be studied together with FMNN05 Simulation tools, 7.5 credits, which is coordinated by LTH.

Subcourses in NUMN26, Numerical Analysis: Simulation Tools

Applies from V21

2101 Simulation Projects, 7,5 hp
Grading scale: Fail, Pass