Faculty of Science

NUMB11, Numerical Analysis: Numerical Linear Algebra, 7.5 credits

Numerisk analys: Numerisk lineär algebra, 7,5 högskolepoäng

First Cycle / Grundnivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2019-12-11 and was last revised on 2024-12-09 by The Education Board of Faculty of Science. The revised syllabus comes into effect 2024-12-09 and is valid from the autumn semester 2025.

General information

The course is an alternatively-compulsory course for first-cycle studies for a Bachelor of Science degree in mathematics.

Language of instruction: English

Main field of study	*Specialisation*
Mathematics with specialization in Numerical Analysis	G2F, First cycle, has at least 60 credits in first-cycle course/s as entry requirements

Learning outcomes

The main goal of the course is for the student to aquire basic knowledge in numerical linear algebra. The course treats numerical methods and principles for solving fundamental problems in linear algebra. The course prepares for further studies in numerical analysis, statistics, computer science and image analysis. Furthermore, the student's ability to solve problems and implement numerical methods in code is trained.

Knowledge and understanding

After completing the course the student should be able to:

- describe iterative methods and their convergence to solve linear systems of equations and eigenvalue problems,

- explain projections and their geometric meaning for solving least-squares problems and large sparse linear systems of equations,
- describe the sensitivity of selected methods and problems with respect to perturbations and the importance of orthogonalisation,
- describe different matrix factorisations, their properties and applications.

Competence and skills

After completing the course the student should be able to:

- identify problems from linear algebra and select appropriate numerical methods to solve them based on mathematical properties of the problems,
- implement numerical methods in a computer program within the framework of the course contents.

Judgement and approach

After completing the course the student should be able to:

- argue for the importance of numerical linear algebra as a tool in other areas, e.g. computer science and mathematical statistics,
- evaluate solution methods for linear algebraic problems according to their complexity and stability properties.

Course content

The course covers:

- Direct and/or iterative solution methods for various linear algebra problems such as linear systems of equations, eigenvalue problems and the least-squares method,
- Matrix and vector norms, orthogonalisation, projection, matrix factorisations, direct and iterative solvers, condition numbers, stability of a method, complexity of an algorithm,
- Applying these concepts to construct numerical methods and solve problems in linear algebra,
- The significance of important matrix classes in numerical linear algebra.

Course design

The teaching consists of lectures. Theoretical home assignments and computer exercises are a central part of the course. These assignments should be solved in smaller groups and reports can be handed in for feedback during the course. The assignments are not compulsory, but they are recommended as preparation for the oral examination at the end of the course.

Assessment

Examination takes the form of an oral exam 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.

Grades

Grading scale includes the grades: Fail, Pass, Pass with distinction
To pass the course it is required that the student can give an account of the course content and questions treated in the home assignments at the oral examination. In addition, for the grade Pass with distinction, the student must be able to answer theoretical questions and questions regarding the algorithms included in the course.

Entry requirements

For admission to the course, students must meet the general entry requirements for higher education, English 6 and 37,5 higher education credits in mathematics including knowledge equivalent to the courses MATA31 Analysis in One Variable, 15 credits, NUMA01 Computational Programming with Python, 7.5 credits, MATA32 Algebra and Vector Geometry 7.5 credits, and MATB32 Linear Algebra, 7.5 credits.

Further information

The course may not be included in a higher education qualification together with NUMA11 Numerical linear algebra 7.5 credits.

The course is given jointly with FMNN01 Numerical Linear Algebra, 7,5 credits, which is coordinated by LTH.

The course is offered at Centre for Mathematical Sciences, Lund University.