

# Numerical Linear Algebra

Programme course

6 credits

Numerisk linjär algebra

TANA15

Valid from: 2017 Spring semester

**Determined by**

Board of Studies for Electrical  
Engineering, Physics and Mathematics

**Date determined**

2017-01-25

## Main field of study

Mathematics, Applied Mathematics

## Course level

Second cycle

## Advancement level

A1X

## Course offered for

- Computer Science and Engineering, M Sc in Engineering
- Applied Physics and Electrical Engineering, M Sc in Engineering
- Mathematics, Master's programme
- Information Technology, M Sc in Engineering
- Applied Physics and Electrical Engineering - International, M Sc in Engineering
- Computer Science and Software Engineering, M Sc in Engineering

## Entry requirements

Note: Admission requirements for non-programme students usually also include admission requirements for the programme and threshold requirements for progression within the programme, or corresponding.

## Prerequisites

Basic course in scientific computing/numerical methods and a course in linear algebra.

## Intended learning outcomes

The course is intended to provide basic knowledge about important matrix decompositions; such as the LU or SVD decompositions, and show how matrix decompositions can be used for analyzing and solving both practical and theoretical problems. The course also covers various important techniques from Linear Algebra, such as the Shur complement, convolutions, polynomial manipulation, or orthogonal basis generation. Both linear, and non-linear, least squares problems are also discussed in the course.

After the course students should be able to:

- Discuss the most common matrix factorizations, and explain their properties.
- Understand how the most common matrix factorizations are computed; and implement numerical algorithms for computing the most important factorizations.
- Use matrix factorizations for solving both theoretical problems and practical problems from applications.
- Discuss the usage of Linear Algebra techniques when solving important application problems, such as pattern recognition, data compression, signal processing, search engines, or model fitting.

## Course content

- Linear algebra: LU-decomposition, SVD, psuedoinvers, orthogonal transformations, Householder transformations, projections, QR-factorisation and least squares problems.
- Eigenvalues: Normal forms, perturbation theory, Rayleigh quotient, the power method, invers iteration, transformation to Hessenberg and tridiagonal form, QR-iteration.
- Non-linear system of equations and least squares problems: Newton's and Gauss-Newton's methods.

## Teaching and working methods

Computer laborations, lectures, exercises, projects and seminars

## Examination

LAB1	Laboratory work	2 credits	U, G
TEN1	Written examination	4 credits	U, 3, 4, 5

The first three course aims are examined with TEN1. The fourth and fifth are examined with LAB1.

## Grades

Four-grade scale, LiU, U, 3, 4, 5

## Department

Matematiska institutionen

## Director of Studies or equivalent

Ingegerd Skoglund

## Examiner

Fredrik Berntsson

## Course website and other links

<http://courses.mai.liu.se/GU/TANA15>

## Education components

Preliminary scheduled hours: 50 h

Recommended self-study hours: 110 h

## Course literature

M T Heath: Scientific Computing. An Introductory Survey, Second edition,  
McGraw Hill, 2002.

## Common rules

Regulations (apply to LiU in its entirety)

The university is a government agency whose operations are regulated by legislation and ordinances, which include the Higher Education Act and the Higher Education Ordinance. In addition to legislation and ordinances, operations are subject to several policy documents. The Linköping University rule book collects currently valid decisions of a regulatory nature taken by the university board, the vice-chancellor and faculty/department boards.

LiU's rule book for education at first-cycle and second-cycle levels is available at [http://stydokument.liu.se/Regelsamling/Innehall/Utbildning\\_pa\\_grund-\\_och\\_avancerad\\_niva](http://stydokument.liu.se/Regelsamling/Innehall/Utbildning_pa_grund-_och_avancerad_niva).