

# Numerical Algorithms in Computer Science

Programme course

4 credits

Datatekniska beräkningar

TANA09

Valid from: 2017 Spring semester

**Determined by**

Board of Studies for Computer Science  
and Media Technology

**Date determined**

2017-01-25

## Main field of study

Mathematics, Applied Mathematics

## Course level

First cycle

## Advancement level

G2X

## Course offered for

- Computer Science and Engineering, M Sc in Engineering
- Information Technology, 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 courses in calculus, linear algebra and programming.

## Intended learning outcomes

In the field Computational mathematics numerical methods, for solving commonly occurring mathematical problems from applications, are developed and analyzed. Important aspects of the methods are robustness, accuracy, and efficiency. Since the methods are intended to be implemented on computers it is also important to know how a computer treats numerical data. After having completed the course the student should be able to:

- explain basic concepts from computational mathematics and also know how a computer stores real numbers and the precision with which different arithmetic operations can be carried out.
- use a selection of numerical methods for solving mathematical problems from applications using a pocket calculator or a computer.
- discuss potential sources of errors in numerical calculations and estimate the accuracy in the computed results.
- use standard mathematical software for solving practical problems from applications.

## Course content

- Error analysis and number representation: The IEEE standard for floating point numbers in computers. The machine precision. Analysis of computational errors. Cancellation. Error propagation and sources of error.
- Linear Algebra: Linear systems of equations. The LU Decomposition. The condition number and error estimate. Least squares problems. The normal equations. Orthogonal bases. Projections. The QR decomposition.
- Non-linear equations: Bisection. Fixed point iteration. Rate of convergence. Newton-Raphson's method. Error estimate.
- Interpolation: Polynomial- and Splineinterpolation. B-splines. Representation of curves and surfaces in computer graphics using Bezier polynomials.

## Teaching and working methods

The course consists of lectures, exercises, and computer exercises.

The theory is presented during the lectures. The numerical algorithms are introduced and analyzed. During the exercises the numerical algorithms are used to solve problems, and estimate the accuracy of the results, using a pocket calculator. During the computer exercises more realistic problems from applications are solved using standard mathematical software.

## Examination

|      |   |             |            |
|------|---|-------------|------------|
| LAB1 | Computer assignments, compulsory attendance at sessions | 1.5 credits | U, G       |
| TEN1 | Written examination                                     | 2.5 credits | U, 3, 4, 5 |

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

## Grades

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

## Other information

Supplementary courses: Numerisk linjär algebra, Numerisk linjär analys

## Department

Matematiska institutionen

## Director of Studies or equivalent

Ingegerd Skoglund

## Examiner

Fredrik Berntsson

## Course website and other links

<http://courses.mai.liu.se/GU/TANA09>

## Education components

Preliminary scheduled hours: 38 h

Recommended self-study hours: 69 h

## Course literature

L Eldén, L Wittmeyer-Koch: Numeriska beräkningar - analys och illustrationer med MATLAB, fjärde upplagan, Studentlitteratur, 2001.

Elfving, Eriksson, Ouchterlony, Skoglund: Numeriska beräkningar - en exempelsamling. Studentlitteratur 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).