SF1667 Applied Linear Algebra II 12.0 credits

Tillämpad linjär algebra II

This is a translation of the Swedish, legally binding, course syllabus.

If the course is discontinued, students may request to be examined during the following two academic years

Establishment

Course syllabus for SF1667 valid from Autumn 2014

Grading scale

A, B, C, D, E, FX, F

Education cycle

First cycle

Main field of study

Technology

Specific prerequisites

Basic and specific requirements for engineering program.

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

An overall goal of the course is that students will develop a good understanding of basic mathematical concepts in algebra and geometry, and use these for mathematical modelling of engineering and scientific problems.

The student should develop skills to illustrate key concepts and solve applied problems, by using a computer and using standard functions from the programming language library. In addition, the student should be able to visualize and present results in a clear manner.

After completing the course students should

- know and be able to use key concepts and methods such as: vector spaces, inner product spaces, subspaces, linear dependence and independence, dimension, bases, norms, inner products, orthogonality, projections, the Gram-Schmidt method.
- know and be able to use key concepts in geometry in R^3: cross product, straight line, plane, normals, surfaces, volumes.
- know and be able to use the L^2-norm and polynomial basis functions.
- know definitions and concepts of matrices, such as: rank, null space, row space, column space, singularity, norms, symmetry, orthogonality.
- be able to calculate the inverse of small matrices analytically and the inverse of large matrices with existing software.
- be able to solve systems of linear equations analytically by Gaussian elimination and pivoting for small systems, and know and be able to use existing software for large systems.
- know the different types of matrix decomposition and apply LU decomposition.
- know the concept of condition number and understand its relevance and calculate it with existing software.
- know the complexity of Gaussian elimination for full and sparse matrices.
- be able to compute eigenvalues and eigenvectors analytically for small systems and for larger systems using existing software, and be able to explain their relevance and connection to physical examples.
- use eigenvalues and eigenvectors to determine if a matrix is diagonalizable.
- formulate the method of least squares for solving overdetermined linear systems of equations and solve small problems by hand and large problems with existing software. In addition, be able to explain important concepts, such as: residual, orthogonality and give a geometric interpretation of a least squares solution in a low dimensional setting.
- know and be able to calculate with complex numbers and their polar form.
- to use the axiom of induction in order to verify simple relations.
- know and be able to use the fundamental theorem of algebra on the connection between factorizations of a polynomial and its zeros.
- break down large problems into manageable parts, and implement these parts as functions in the program language.
- use control flow and data structures.
- manage files in different ways, both for input and output.

- use standard functions from the programming language libraries (eg Matlab library) for calculation, visualization and efficient programming.
- write well-structured programs.

Course contents

Basic ideas and concepts: vector, matrix, linear equations, Gaussian elimination, matrix decomposition, complexity, vector geometry with scalar and cross product, determinant, vector spaces, linear independence, basis, linear transformations, eigenvalues, eigenvectors, least squares method, orthogonality, inner product, the Gram Schmidt method, complex numbers, the axiom of induction, fundamental theorem of algebra.

Computational aspects: programming in matlab, solution of linear equations, Gaussian elimination, LU decomposition, condition number, full and sparse matrices, complexity, least squares method, calculation of eigenvalues and eigenvectors, visualization of results.

Course literature

Contemporary Linear Algebra by Howard Anton and Robert C. Busby, 2003, ISBN 978-0-0471-16362-6

Numerical Analysis by Timothy Sauer (2nd edition or New International edition)

Matlab 7 i korthet

Exempelsamling i numeriska metoder by Edsberg et al

Examination

- LAB1 - Lab Assignments, 2.0 credits, grading scale: P, F
- LAB2 - Lab Assignments, 3.0 credits, grading scale: P, F
- PRO1 - Project, 1.0 credits, grading scale: P, F
- TEN1 - Examination, 6.0 credits, grading scale: A, B, C, D, E, FX, F

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

Other requirements for final grade

Written exam (TEN1; 6 cr). Computer assignments with oral and written presentation (LAB1 and LAB2; 5 cr) and a project (PRO1; 1 cr)

Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.