SF1675 Applied Linear Algebra 13.5 credits

Tillämpad linjär algebra

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

Establishment

Course syllabus for SF1675 valid from Autumn 2016

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 to develop a good understanding of basic mathematical concepts and concepts within applied linear algebra and to use these to mathematically model engineering and science problems. In addition, the student will learn basic programming in MATLAB as well as develop a skill in using MATLAB to solve applied problems.

In the linear algebra part of the course, the student should, after passing the couirse, be able to use the basic concepts and problem solving methods in applied linear algebra. In particular, it means

- understand, interpret and use the basic concepts: the vector space R^n, subspaces of R^n, linear dependence and independence, dimension, base, linear transformation, matrix, determinant, eigenvalue and eigenvector.
- be able to use key concepts in geometry in R^2 and R^3 such as: vectors, the scalar product, the cross product, straight lines, planes, normals, surfaces, volumes, projections.
- be able to use Gaussian elimination with pivotation to solve systems of linear equations.
- knowing different types of matrix factorizations as well as applying LU factorization.
- know the complexity of Gaussian elimination and explain how it affects the calculation cost.
- know the concept of condition number and understand its relevance to the accuracy of the solution of linear equation systems.
- be able to calculate the inverse and determinant of a matrix.
- be able to use matrix and determinants to answer questions about linear mappings and systems of linear equations.
- know definitions and concepts related to matrices and linear mappings, such as: rank, null space, image space, row space, column space, singular values, norm, symmetry and orthogonality.
- be able to use the least squares method to solve overdetermined linear equation systems.
- be able to use different bases for vector spaces to handle vectors, linear mappings, and to handle change of basis and linear coordinate transformations.
- be able to calculate eigenvalues and eigenvectors and use this, for example, to diagonalize matrices and study quadratic forms.
- be able to use the Euclidean inner product to handle distances, orthogonality and projections, as well as apply Gram-Schmid's method to calculate orthogonal bases for subspaces.
- set up and solve simple mathematical models for engineering problems where the basic concepts of applied linear algebra come to use, as well as discuss the models, relevance, reasonableness and accuracy of the models.

Use MATLAB to

- perform calculations with matrices and vectors.
- calculate matrix inverse, determinant and eigenvalues.
- efficiently solve linear equation systems with large system matrices.
- calculate LU factorization.

- read and comprehend mathematical text on linear algebra and its applications, as well as communicate mathematical reasoning and calculations in this field orally and in writing in an easy-to-follow manner.

In addition, for higher grades the student should be able to

- derive important relationships within applied linear algebra.

- generalize and adapt methods to use in partly new situations.

- solve problems that require synthesis of materials and ideas from the whole course.

- explain the theory behind key concepts.

In the programming part of the course, the student is required to complete the course

- know basic MATLAB programming and software design.

- be able to write and use MATLAB's built-in functions.

- be able to write well-structured and efficient programs.

- be able to use different strategies for debugging.

- master file management.

Course contents

Basic ideas and concepts: vectors, matrices, systems of linear equations, Gaussian elimination, matrix factorization, complexity, vector geometry with scalar product and vector product, determinants, vector spaces, linear independence, bases, change of basis, linear mappings, eigenvalue, eigenvector, the least squares methods, orthogonality, Gram-Schmidt's method.

Calculation and programming technical aspects: MATLAB programming with control and data structures, file management, functions, visualization, numerical solution of systems of linear equations with Gaussian elimination and LU factorization, experimental determination of complexity in solving linear equation systems, numerical calculation of condition numbers, assessment of accuracy, graphical illustration of results.

Course literature

The literature is published on the course webpage no later than four weeks before the course starts.

Examination

- PRO1 - Project, 1.0 credits, grading scale: P, F

- TEN2 - Examination, 7.5 credits, grading scale: A, B, C, D, E, FX, F

- TEN1 - Examination, 1.5 credits, grading scale: P, F

- LAB2 - Laboratory Sessions, 2.0 credits, grading scale: P, F

- LAB1 - Laboratory Sessions, 1.5 credits, grading scale: P, 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.

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

In this course, the code of honour of the school is applied,
see: http://www.sci.kth.se/institutioner/math/avd/na/utbildning/hederskodex-for-studenter-och-larare-vid-kurser-pa-avdelningen-for-numerisk-analys-1.357185

Other requirements for final grade

Two exams (TEN1 and TEN2; 9 cr). Laboratory assignments with verbal and written presentation (LAB1 and LAB2; 3.5 cr). 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.