Engineering Tripos Part IB, 2P7: Linear Algebra, 2023-24

Lecturer

Dr J.P. Jarrett [1]

Timing and Structure

Weeks 4 & 8 Lent Term 1 lecture/week; weeks 5-7 Lent Term 2 lectures/week. 8 lectures

Aims

The aims of the course are to:

- Introduce the ideas and techniques of Linear Algebra, and illustrate some of their applications in engineering.

Objectives

As specific objectives, by the end of the course students should be able to:

- For all objectives, complete calculations by hand for small problems, or by using Matlab for larger problems (the IB Computing Course deals with this in detail).
- Solve a set of linear equations using Gaussian elimination, and complete the LU factorisation of a matrix.
- Understand, and be able to calculate bases for the four fundamental subspaces of a matrix.
- Calculate the least squares solution of a set of linear equations.
- Orthogonalize a set of vectors, complete the QR factorisation of a matrix, and be able to use this to find the least squares solution of a set of linear equations.
- Find the eigenvalues and eigenvectors of a matrix, and complete the A = SL S-1 or A = QL QT factorisations as appropriate.
- Find the SVD of a matrix, and to understand how this can be used to calculate the rank of the matrix, and to provide a basis for the each of its fundamental subspaces.

Content

- Solution of the matrix equation $Ax = b$: Gaussian elimination, LU factorization, the four fundamental subspaces of a matrix.
- Least squares solution of $Ax = b$ for an $m \times n$ matrix with n independent columns: Gram-Schmidt orthogonalization, QR decomposition.
- Solution of $Ax = \lambda x$, eigenvectors and eigenvalues.
- Singular Value Decomposition.

Booklists

Please refer to the Booklist for Part IB Courses for references to this module, this can be found on the associated Moodle course.

Examination Guidelines

Please refer to Form & conduct of the examinations [2].

UK-SPEC

This syllabus contributes to the following areas of the UK-SPEC [3] standard:

Toggle display of UK-SPEC areas.

IA1

Apply appropriate quantitative science and engineering tools to the analysis of problems.

KU1

Demonstrate knowledge and understanding of essential facts, concepts, theories and principles of their engineering discipline, and its underpinning science and mathematics.

KU2

Have an appreciation of the wider multidisciplinary engineering context and its underlying principles.

E2

Ability to extract data pertinent to an unfamiliar problem, and apply its solution using computer based engineering tools when appropriate.

E3

Ability to apply mathematical and computer based models for solving problems in engineering, and the ability to assess the limitations of particular cases.

P8

Ability to apply engineering techniques taking account of a range of commercial and industrial constraints.

US1

A comprehensive understanding of the scientific principles of own specialisation and related disciplines.

US2

A comprehensive knowledge and understanding of mathematical and computer models relevant to the engineering discipline, and an appreciation of their limitations.

US3

An understanding of concepts from a range of areas including some outside engineering, and the ability to apply them effectively in engineering projects.

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Links
[1] mailto:jpj1001@cam.ac.uk
[2] https://teaching23-24.eng.cam.ac.uk/content/form-conduct-examinations
[3] https://teaching23-24.eng.cam.ac.uk/content/uk-spec