

## Engineering Tripos Part IB, 2P7: Linear Algebra, 2021-22

### 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  $A = QL Q^T$  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 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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ib-2p7-linear-algebra-2021-22

### Links

[1] <mailto:jpj1001@cam.ac.uk>

[2] <https://teaching.eng.cam.ac.uk/content/form-conduct-examinations>

[3] <https://teaching.eng.cam.ac.uk/content/uk-spec>