<table>
<thead>
<tr>
<th>Location</th>
<th>NYU London</th>
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<tbody>
<tr>
<td>Class code</td>
<td>MATH-UA-9140</td>
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<tr>
<td>Instructor Details</td>
<td>Dr Mark Roberts</td>
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<tr>
<td>Class Details</td>
<td>Linear Algebra</td>
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<tr>
<td>Prerequisites</td>
<td>Calculus 1 with a C or higher (or equivalent)</td>
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**Class Description**

This is an introductory course on linear algebra, one of the most important and basic areas of mathematics, with many real-life applications. The course introduces students to both the theory of vector spaces and linear transformations and the techniques such as row-reduction of matrices and diagonalisation, which can be applied to problems in areas such as engineering, economics, and mathematical biology.

As well as mastering techniques, it is important that the students get to grips with the more abstract ideas of linear algebra, and learn to understand and write correct mathematical arguments. Taking an active approach to problem-solving is also important.

The class will consist of a mixture of lectures, working on problems and class discussions. Each class will correspond to two or three sections of the recommended text, which students will be expected to read. There will be weekly assignments, which are a very important part of the learning process: actively engaging with the mathematics is crucial.

**Desired Outcomes**

By the end of the course, students should be able to:

1. Understand the basic theory of vector spaces: linear independence, spanning, bases, dimension, subspaces.

2. Understand the basic theory of linear transformations: matrix representation, diagonalisation, orthogonal diagonalisation.

3. Carry out the basic techniques of the following: row-reduction and LU decomposition to solve systems of linear equations; calculating determinants; finding eigenvalues and eigenvectors and diagonalising matrices; orthogonally diagonalising matrices.

4. Apply linear algebra to solve some real-life problems.

Be able to work with formal mathematical arguments.

**Assessment Components**

- Weekly homework exercises and class quizzes 30%
- Two mid-term exams 15% each
- Final exam 40%
Homework exercises can be completed using pen and paper. Students may find it helpful to discuss problems together, but must always write up their solutions separately to avoid plagiarism.

Failure to submit or fulfil any required course component results in failure of the class.

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<tr>
<th>Assessment Expectations</th>
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<tbody>
<tr>
<td><strong>Grade A:</strong> Good understanding of ideas: ability to carry out calculations accurately: ability to produce and understand proofs and solve unseen problems.</td>
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<tr>
<td><strong>Grade B:</strong> Reasonable understanding of ideas: ability to carry our calculations accurately: some ability to produce proofs and solve unseen problems.</td>
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<tr>
<td><strong>Grade C:</strong> Reasonable understanding of ideas: ability to carry our calculations fairly accurately.</td>
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<tr>
<td><strong>Grade D:</strong> Basic understanding of ideas and ability to carry our calculations with some degree of success</td>
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<td><strong>Grade F:</strong> Ideas not understood and inability to do calculations</td>
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<tr>
<th>Required Text(s)</th>
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<tr>
<th>Supplemental Text(s) (not required to purchase as copies are in NYU-L Library)</th>
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<tr>
<th>Internet Research Guidelines</th>
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<th>Additional Required Equipment</th>
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### Session 1
1.1 Systems of linear equations  
1.2 Row reduction and echelon form  
1.3 Vector equations  
[Numbers are references to sections of the text by Lay]

### Session 2
1.4 Matrix equations  
1.5 Solutions sets of linear systems  
1.7 Linear independence  
*Hand in homework 1*

### Session 3
1.8 Introduction to linear transformations
1.9 The matrix of a linear transformation
2.1 Matrix operations
Hand in homework 2

Session 4
2.2 The inverse of a matrix
2.3 Characterizations of invertible matrices
2.4 Partitioned matrices
Hand in homework 3

Session 5
2.5 Matrix factorizations
3.1 Introduction to determinants
3.2 Properties of determinants
Hand in homework 4

Session 6
4.1 Vector Spaces
4.2 Null spaces, column spaces, linear transformations
4.3 Linearly independent sets; bases
Hand in homework 5

Session 7
Mid-term 1
4.4 Coordinate systems

Session 8
4.5 The dimension of a vector space
4.6 Rank
4.7 Change of basis
Hand in homework 6

Session 9
Applications
Revision/catch up
Hand in homework 7
Spring break – no class on April 3

Session 10
5.1 Eigenvectors and eigenvalues
5.2 The characteristic equation
5.3 Diagonalisation
Hand in homework 8

Session 11
5.4 Eigenvectors and linear transformations
6.1 Inner products
6.2 Orthogonal sets
Hand in homework 9
### Session 12
**Mid-term 2**
6.3 Orthogonal projections

### Session 13
6.4 Gram-Schmidt process
6.5 Least squares problem
7.1 Diagonalization of symmetric matrices
*Hand in homework 10*

### Session 14
7.2 Quadratic forms
Catch-up/Revision
*Hand in homework 11*

### Session 15
*Final exam*

### Classroom Etiquette
Mobile phones off

### Required Co-curricular Activities
n/a

### Estimated Travel Costs
n/a

### Suggested Co-curricular Activities
n/a

### Your Instructor
Departmental Tutor and lecturer in the Mathematics Department at UCL. I currently teach first year algebra and Galois Theory to undergraduates at UCL. My research interests are in abstract algebra, in particular non-commutative ring theory.

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**NYU GLOBAL ACADEMIC POLICIES**

Policies and procedures for Global Academic Centres, including policies on academic integrity and the Study Away Standard, can be found here: [https://www.nyu.edu/about/policies-guidelines-compliance/policies-and-guidelines/student-services.html](https://www.nyu.edu/about/policies-guidelines-compliance/policies-and-guidelines/student-services.html)
Absences: Key information on NYU London’s absence policy, how to report absences, and what kinds of absences can be excused can be found here: http://www.nyu.edu/london/academics/attendance-policy.html

NYU London work submission policies can be found here: http://www.nyu.edu/london/academics/academic-policies.html

Classroom conduct: Academic communities exist to facilitate the process of acquiring and exchanging knowledge and understanding, to enhance the personal and intellectual development of its members, and to advance the interests of society. Essential to this mission is that all members of the University Community are safe and free to engage in a civil process of teaching and learning through their experiences both inside and outside the classroom. Accordingly, no student should engage in any form of behaviour that interferes with the academic or educational process, compromises the personal safety or well-being of another, or disrupts the administration of University programs or services.

Please refer to the NYU London Disruptive Student Behaviour Policy at https://goo.gl/NvtSv1 for examples of disruptive behaviour and guidelines for response and enforcement.