UNSW Course Outline

MATH2601 Higher Linear Algebra - 2024

Published on the 13 May 2024

General Course Information

Course Code : MATH2601
Year : 2024
Term : Term 2
Teaching Period : T2
Is a multi-term course? : No
Faculty : Faculty of Science
Academic Unit : School of Mathematics & Statistics
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : Kensington
Campus : Sydney
Study Level : Undergraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

The course begins with a revision and extension of material on vector spaces, linear transformations, basis and dimension from first year. It also covers inner products over both the real and complex fields, orthogonalization, reflections, QR factorizations and unitary, self-adjoint

and normal transformations. It then turns to the study of eigenvalues and eigenvectors, diagonalization and Jordan forms and functions of matrices. The course also includes applications to linear systems of differential equations, quadratics and rotations as time permits. The course is primarily but not exclusively intended for students aiming to complete honours in applied mathematics, pure mathematics, statistics or data science, and so where content is in common with MATH2501, MATH2601, aims to give students a deeper level of understanding. The course consists of lectures and tutorials, where the latter may be run as active classrooms.

Course Aims

The principal aim of this subject is for students to develop a working knowledge of the central ideas of linear algebra: vector spaces, linear transformations, orthogonality, eigenvalues and eigenvectors, canonical forms and applications of these ideas in science and engineering. In particular, the course introduces students to one of the major themes of modern mathematics: classification of structures and objects. Using linear algebra as a model, we will look at techniques that allow us to tell when two apparently different objects can be treated as if they were the same. A secondary aim is to understand how certain calculations in linear algebra can be thought of as algorithms, that is, as fixed methods which will lead in finite time to solutions of whole classes of problems. Additionally, there will be a focus on writing clear mathematical proofs.

Relationship to Other Courses

This 6UOC course is the Higher version of the core second year mathematics topic MATH2501 Linear Algebra. Either this course or MATH2501 is required for completion of a mathematics or statistics major or the data science & decisions program. MATH2501 and MATH2601 are also compulsory or recommended for several other majors and programs. MATH2601 is required for all maths or stats majors in advanced science and is required by all students an advanced mathematics degree.

Formally, entry to MATH2601 requires a mark of 70 in first year. Past experience indicates that students who have not achieved this grade struggle with the course. MATH2601 contains a large amount of extra, theoretical material compared to MATH2501. The marks in MATH2601 are usually adjusted to account for this.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Describe the structure and properties of finite dimensional vector spaces over the real, complex and simple finite fields.
CLO2 : Apply the key ideas of linear algebra to a range of theoretical and applied problems.
CLO3 : Provide clear and logically written mathematical calculations and proofs.

Course Learning Outcomes	Assessment Item
CLO1 : Describe the structure and properties of finite dimensional vector spaces over the real, complex and simple finite fields.	• Class Test 1 • Class Test 2 • Final Exam
CLO2 : Apply the key ideas of linear algebra to a range of theoretical and applied problems.	• Short assignment • Class Test 1 • Class Test 2 • Final Exam
CLO3 : Provide clear and logically written mathematical calculations and proofs.	• Short assignment • Class Test 1 • Class Test 2 • Final Exam

Learning and Teaching Technologies

Moodle - Learning Management System | Echo 360 | Blackboard Collaborate

Learning and Teaching in this course

Lectues will be conducted face-to-face, but I will also provide a complete set of pre-recorded videos that the previous lecturer made for use during the pandemic. If we omit details of some proofs during the face-to-face lectures then I will refer you to the videos. See Moodle for more details.

Tutorials begin in week 1 and will be run on an "active classroom" model. This means that you will split up into groups of 2 or 3, and be provided with a short list of problems on the topics covered in the previous week or so of lectures (or the pre-requisite material in week 1). You are expected to go through these problems in small groups, writing the solutions on the whiteboards (we will provide pens). Your tutor will assist you if you get stuck, but the point is to get you used to thinking through the problems and writing them up neatly and coherently. See Moodle for more details.

There will also be a set of practice problems for you to cover in your own time as a way of practicing the techniques taught and reinforcing learning. I have included a schedule for these to match up the lecture/video schedule.

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Class Test 1 Assessment Format: Individual	21%	Start Date: See description Due Date: Week 4: 17 June - 23 June
Short assignment Assessment Format: Individual	10%	Start Date: Not Applicable Due Date: 07/07/2024 11:55 PM
Class Test 2 Assessment Format: Individual	21%	Start Date: See description Due Date: Week 9: 22 July - 28 July
Final Exam Assessment Format: Individual	48%	Start Date: Not Applicable Due Date: Exam period

Assessment Details

Class Test 1

Assessment Overview

Your first Class Test will be held in Week 4.

It consists of an online component (worth 6%) completed online using Mobius which will be open for at least 4 days. The remaining 15% will be a written test lasting between 40 and 60 minutes, which will be administered during one of the lecture blocks: the exact time will be announced at the start of the Term.

This test will cover material in the lectures for Weeks 1 to 3, including revision material on first-year linear algebra.

You will receive results after each online test has closed. Marks and feedback on the written components will be provided 2 weeks after the test.

Course Learning Outcomes

- CLO1 : Describe the structure and properties of finite dimensional vector spaces over the real, complex and simple finite fields.
- CLO2 : Apply the key ideas of linear algebra to a range of theoretical and applied problems.
- CLO3 : Provide clear and logically written mathematical calculations and proofs.

Detailed Assessment Description

Your first Class Test will be held in Week 4.

It consists of an online component (worth 6%) completed online using Mobius which will be open for at least 4 days. The remaining 15% will be a written test lasting between 40 and 60 minutes, which will be administered during one of the lecture blocks: the exact time will be announced at the start of the Term.

This test will cover material in the lectures for Weeks 1 to 3, including revision material on first-year linear algebra.

You will receive results after each online test has closed. Marks and feedback on the written components will be provided 2 weeks after the test.

Assessment Length

See description

Assessment information

Late submission is not applicable to class test.

Assignment submission Turnitin type

Not Applicable

Short assignment

Assessment Overview

The assignment will be released by the end of Week 3 and due at the due at the end of Week 6. The content will be focused on material from roughly the first third of the course. The main purpose of the assignment is for you to practice writing good mathematics. The assignment will be returned to you with feedback two weeks after the submission date.

Course Learning Outcomes

- CLO2 : Apply the key ideas of linear algebra to a range of theoretical and applied problems.
- CLO3 : Provide clear and logically written mathematical calculations and proofs.

Detailed Assessment Description

The assignment will be released by the end of week 3 and due at the due at the end of week 6. The content will be focused on material from roughly the first three weeks of the course and the revision material. The main purpose of the assignment is for you to practice writing good mathematics. The assignment will be returned to you with feedback two weeks after the

submission date.

Assessment Length

No more than 10 pages (although 2 might be enough)

Submission notes

Can be hand written or typed in e.g. Word or LaTeX. To be submitted via moodle

Assessment information

Late submission without special consideration is **not** permitted.

Assignment submission Turnitin type

Not Applicable

Class Test 2

Assessment Overview

Your second Class Test will be held in Week 9.

It consists of an online component (worth 6%) completed online using Mobius which will be open for at least 4 days. The remaining 15% will be a written test lasting between 40 and 60 minutes, which will be administered during one of the lecture blocks: the exact time will be announced at the start of the Term.

This test will cover material in the lectures for Weeks 4 to 8.

You will receive results after each online test has closed. Marks and feedback on the written components will be provided 2 weeks after the test.

Course Learning Outcomes

- CLO1 : Describe the structure and properties of finite dimensional vector spaces over the real, complex and simple finite fields.
- CLO2 : Apply the key ideas of linear algebra to a range of theoretical and applied problems.
- CLO3 : Provide clear and logically written mathematical calculations and proofs.

Detailed Assessment Description

Your second Class Test will be held in Week 9.

It consists of an online component (worth 6%) completed online using Mobius which will be open for at least 4 days. The remaining 15% will be a written test lasting between 40 and 60

minutes, which will be administered during one of the lecture blocks: the exact time will be announced at the start of the Term.

This test will cover material in the lectures for Weeks 4 to 8.

You will receive results after each online test has closed. Marks and feedback on the written components will be provided 2 weeks after the test.

Assessment Length

See description

Assessment information

Late submission is not applicable to class test.

Assignment submission Turnitin type

Not Applicable

Final Exam

Assessment Overview

The final exam is a 2 hour exam run in the standard examination period. The exam will cover the whole course but have an emphasis on the second half. You may inspect your script under the usual UNSW and School processes. Solutions and general comments may be provided after any supplementary exam has been completed, or results are released whichever occurs later.

Course Learning Outcomes

- CLO1 : Describe the structure and properties of finite dimensional vector spaces over the real, complex and simple finite fields.
- CLO2 : Apply the key ideas of linear algebra to a range of theoretical and applied problems.
- CLO3 : Provide clear and logically written mathematical calculations and proofs.

Detailed Assessment Description

The final exam is a 2 hour exam run in the standard examination period. The exam will cover the whole course but have an emphasis on the second half. You may inspect your script under the usual UNSW and School processes. Solutions and general comments may be provided after any supplementary exam has been completed, or results are released whichever occurs later.

Assessment Length

2 hours

Submission notes

In person exam, so hand written

Assessment information

Late submission is not applicable to exam.

Assignment submission Turnitin type

Not Applicable

General Assessment Information

More detail on assessment, including examples of past tests and exams with solutions, will be posted on Moodle.

Grading Basis

Standard

Requirements to pass course

A composite mark of at last 50 (after any recalibration) is required to pass the course. There are no specific hurdle requirements, e.g. it is not compulsory to sit all the tests or the exam.

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 27 May - 2 June	Lecture	Chapter 1: Introduction, Groups, Fields. Chapter 2 (Vector Spaces). Definition and examples of vector spaces
	Homework	Practice Problems, Qs 1 to 14
Week 2 : 3 June - 9 June	Lecture	Chapter 2 (Vectors Spaces): Subspaces, Linear Independence and Span, Bases, Dimension, Coordinates, Sums and Direct Sums,
	Homework	Practice problems Qs 15-26
Week 3 : 10 June - 16 June	Lecture	Chapter 3 (Linear Transformations): Linearity, Kernel and Image, Matrix of a Linear Map, Normal Form
	Homework	Practice problems Qs 27-39
Week 4 : 17 June - 23 June	Lecture	Chapter 3 (Linear Transformations): Similarity, multilinearity. Chapter 4 (Inner Product spaces): Dot products, General Inner Products,Orthogonality Also: First Class Test in this week
	Homework	Practice problems Qs 40-52
Week 5 : 24 June - 30 June	Lecture	Chapter 4 (Inner Product Spaces): Gram-Schmidt, complements, adjoints
	Homework	Practice problems Qs 53-62
Week 6 : 1 July - 7 July	Assessment	Assignment due by the end of the week. No lectures or tutorials.
Week 7 : 8 July - 14 July	Lecture	Chapter 4 (Inner Product Spaces): Least squares. Chapter 5: Determinants and their properties Chapter 6 (Eigenvalues and Eigenvectors): Definition of eigenvector and eigenvalue; characteristic polynomial.
	Homework	Practice problems Qs 63-70
Week 8 : 15 July - 21 July	Lecture	Chapter 6 (Eigenvalues and Eigenvectors): Multiplicities, normal operators, self adjoint and unitary operators, singular value decomposition
	Homework	Practice problems Qs 71-87
Week 9 : 22 July - 28 July	Lecture	Chapter 7 (The Jordan Form) Also: Class test 2 in this week.
	Homework	Practice problems Qs 88-98
Week 10 : 29 July - 4 August	Lecture	Chapter 8 (Functions of Matrices and ODEs)
	Homework	Practice problems Qs 99-114 (and beyond!)

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

Course Resources

Prescribed Resources

There is no set textbook and no one book covers all the course. The lectures, available through Moodle, will comprehensively cover the material and the lectures will define the course.

Lecture notes will be made available through Moodle. I provide skeleton lecture notes with gaps for working on the examples in lectures. The lectures will be based on those and the lecturer will write further, e.g. solve problems. It is probably best to print the lectures notes (maybe 2 to a

page) and bring them to lectures, where you can write on them the solutions to problems etc. The notes have colours but a black-and-white printout is fine.

Note that some of the assessments are online (using Mobius) will require internet access and others may require the ability to scan and electronically submit written material. See moodle for more detail.

Recommended Resources

There are many texts on Linear Algebra in the library; you may want to look at:

- *Linear algebra done right* by S. Axler (P512.5/235)
- *Elementary linear algebra* by H. Anton (P512.897/153J)
- *Finite--dimensional vector spaces* by P.R. Halmos (P512.86/27)
- *Linear algebra* by J.B. Fraleigh and R.A. Beauregard (P512.897/184)
- *Linear algebra* by M. O'Nan and H.Enderton (P512.5/239)

Course Evaluation and Development

The School of Mathematics and Statistics evaluates each course each time it is run. We carefully consider the student responses and their implications for course development. Feedback is very important to us, so please don't leave it to the end of the course to pass on any ideas.

In the past we have adjusted the weighting of assessment tasks, introduced online testing, modified the tutorial problems and provided solutions to that year's exam after completion of the course in response to feedback received.

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Catherine Greenhill		Anita Lawrence 5105		See Moodle	Yes	Yes

Other Useful Information

Academic Information

Upon your enrolment at UNSW, you share responsibility with us for maintaining a safe, harmonious and tolerant University environment.

You are required to:

- Comply with the University's conditions of enrolment.
- Act responsibly, ethically, safely and with integrity.
- Observe standards of equity and respect in dealing with every member of the UNSW community.
- Engage in lawful behaviour.
- Use and care for University resources in a responsible and appropriate manner.
- Maintain the University's reputation and good standing.

For more information, visit the UNSW Student Code of Conduct Website.

Academic Honesty and Plagarism

Referencing is a way of acknowledging the sources of information that you use to research your assignments. You need to provide a reference whenever you draw on someone else's words, ideas or research. Not referencing other people's work can constitute plagiarism.
Further information about referencing styles can be located at https://student.unsw.edu.au/referencing

Academic integrity is fundamental to success at university. Academic integrity can be defined as a commitment to six fundamental values in academic pursuits: honesty, trust, fairness, respect, responsibility and courage. At UNSW, this means that your work must be your own, and others' ideas should be appropriately acknowledged. If you don't follow these rules, plagiarism may be detected in your work.
Further information about academic integrity, plagiarism and the use of AI in assessments can be located at:

- The Current Students site,
- The ELISE training site, and
- The Use of AI for assessments site.

The Student Conduct and Integrity Unit provides further resources to assist you to understand your conduct obligations as a student: https://student.unsw.edu.au/conduct

Submission of Assessment Tasks

Penalty for Late Submissions

UNSW has a standard late submission penalty of:

- 5% per day,

- for all assessments where a penalty applies,
- capped at five days (120 hours) from the assessment deadline, after which a student cannot submit an assessment, and
- no permitted variation.

Any variations to the above will be explicitly stated in the Course Outline for a given course or assessment task.

Students are expected to manage their time to meet deadlines and to request extensions as early as possible before the deadline.

Special Consideration

If circumstances prevent you from attending/completing an assessment task, you must officially apply for special consideration, usually within 3 days of the sitting date/due date. You can apply by logging onto myUNSW and following the link in the My Student Profile Tab. Medical documentation or other documentation explaining your absence must be submitted with your application. Once your application has been assessed, you will be contacted via your student email address to be advised of the official outcome and any actions that need to be taken from there. For more information about special consideration, please visit: https://student.unsw.edu.au/special-consideration

Important note: UNSW has a "fit to sit/submit" rule, which means that if you sit an exam or submit a piece of assessment, you are declaring yourself fit to do so and cannot later apply for Special Consideration. This is to ensure that if you feel unwell or are faced with significant circumstances beyond your control that affect your ability to study, you do not sit an examination or submit an assessment that does not reflect your best performance. Instead, you should apply for Special Consideration as soon as you realise you are not well enough or are otherwise unable to sit or submit an assessment.

Faculty-specific Information

Additional support for students

- The Current Students Gateway
- Student Support
- Academic Skills and Support
- Student Wellbeing, Health and Safety
- Equitable Learning Services
- UNSW IT Service Centre
- Science EDI Student Initiatives, Offerings and Guidelines

School-specific Information

School of Mathematics and Statistics and UNSW Policies

The School of Mathematics and Statistics has adopted a number of policies relating to enrolment, attendance, assessment, plagiarism, cheating, special consideration etc. These are in addition to the Policies of The University of New South Wales. Individual courses may also adopt other policies in addition to or replacing some of the School ones. These will be clearly notified in the Course Initial Handout and on the Course Home Pages on the Maths Stats web site. Students in courses run by the School of Mathematics and Statistics should be aware of the School and Course policies by reading the appropriate pages on the web site starting at: The School of Mathematics and Statistics assessment policies

The School of Mathematics and Statistics will assume that all its students have read and understood the School policies on the above pages and any individual course policies on the Course Initial Handout and Course Home Page. Lack of knowledge about a policy will not be an excuse for failing to follow the procedure in it.

Special Consideration - Short Extension Policy

The School of Mathematics and Statistics has carefully reviewed its range of assignments and projects to determine their suitability for automatic short extensions as set out by the UNSW Short Extension Policy. Upon comprehensive examination of our course offerings that incorporate these types of assessments, we have concluded that our current deadline structures already accommodate the possibility of unexpected circumstances that may lead students to require additional days for submission. Consequently, the School of Mathematics and Statistics has decided to universally opt out of the Short Extension provision for all its courses, having pre-emptively integrated flexibility into our assessment deadlines. The decision is subject to revision in response to the introduction of new course offerings. Students may still apply for Special Consideration via the usual procedures.

Computing Lab

The main computing laboratory is room G012 of the Anita B.Lawrence Centre (formerly Red Centre). You can get to this lab by entering the building through the main entrance to the School of Mathematics (on the Mezzanine Level) and then going down the stairs to the Ground Level. A second smaller lab is Room M020, located on the mezzanine level through the glass door (and

along the corridor) opposite the School's entrance.

For more information, including opening hours, see the computing facilities webpage. Remember that there will always be unscheduled periods when the computers are not working because of equipment problems and that this is not a valid excuse for not completing assessments on time.

School Contact Information

Please visit the School of Mathematics and Statistics website for a range of information.

For information on Courses, please go to “Student life & resources” and either Undergraduate and/or Postgraduate and respective "Undergraduate courses" and "Postgraduate courses" for information on all course offerings.

All school policies, forms and help for students can be located by going to the "Student Services" within “Student life & resources” page. We also post notices in "Student noticeboard" for your information. Please familiarise yourself with the information found in these locations. If you cannot find the answer to your queries on the web you are welcome to contact the Student Services Office directly.

Undergraduate

E: ug.mathsstats@unsw.edu.au

P: 9385 7011 or 9385 7053

Postgraduate

E: pg.mathsstats@unsw.edu.au

P: 9385 7053

Should we need to contact you, we will use your official UNSW email address of in the first instance. **It is your responsibility to regularly check your university email account. Please use your UNSW student email and state your student number in all emails to us.**