



FACULTY OF SCIENCE
SCHOOL OF MATHEMATICS AND STATISTICS

MATH2601
HIGHER LINEAR ALGEBRA
Semester 1, 2018

MATH2601 – Course Outline

Course Authority and lecturer: David Angell, Red Centre 3093, phone 9385 7061, email david.angell@unsw.edu.au.

Consultation hours: TBA.

Credit: 6 Units of Credit (6UOC).

Prerequisites: MATH1231 or MATH1241 or MATH1251, each with a mark of at least 70.

Exclusions: MATH2501.

Lectures will be held in weeks 1–7 and 9–13 on Wednesdays from 9 am to 11 am, and in weeks 1–12 on Thursdays from 2 pm to 4 pm. All lectures will be in Mathews Lecture Theatre D. (Note that Wednesday week 8 is a public holiday.)

Tutorials. There will be one tutorial per week, from week 2 to week 13. Available times (unless they are already full up) are Wednesdays 5 pm, Thursdays 12 noon, Fridays 1 pm and Fridays 2 pm.

About this course. 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. MATH2501 and MATH2601 are also compulsory or recommended for several other programs. MATH2601 is highly recommended for students intending to proceed to Honours in mathematics.

Higher or Ordinary? 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. Apart from the deeper understanding that this brings, its reward is that the marks of both classes are scaled to make sure that the grades reflect the greater difficulty of MATH2601. Many more distinctions and high distinctions are awarded in MATH2601 than in MATH2501. The pass rate in MATH2601 is usually very high (as it should be with the quality of students in the course). However, **do not** believe the rumours that say “nobody ever fails higher” – you will have to work hard to get any benefit from studying this course.

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.

Student learning outcomes. By regularly attending lectures, attempting practice problems and participating in tutorials, you will

- develop an understanding of the main ideas of linear algebra,
- apply these ideas to a range of theoretical and applied problems,
- gain experience in the written presentation of mathematical calculations and proofs.

Relation to graduate attributes. The above outcomes are related to the development of the Science Faculty Graduate Attributes, in particular: 1. Research, inquiry and analytical thinking abilities, 4. Communication.

Teaching strategies underpinning the course. New ideas and skills are introduced and demonstrated in lectures, then students develop these skills by applying them to specific tasks in tutorials and assessments. Students should attend all classes, prepare for lectures by reading through previous lecture notes, and work through practice problems prior to the tutorial. Tutorials will be run on the “flipped classroom” model, where students will work in groups of two or three on problem sets. The tutor will offer help or feedback when needed, and will also discuss the problems with groups in order to ensure that every student understands his/her group’s solution.

Rationale for learning and teaching strategies. The course is structured to create a climate of enquiry in which students are actively engaged in the learning process. The emphasis is on problem-solving in tutorials and in the assessment; students are expected to devote the majority of their study time to this.

Assessment. UNSW assesses students under a “standards based” assessment policy. For more information on how this policy is applied in the School of Mathematics and Statistics, see www.maths.unsw.edu.au/currentstudents/assessment-policies. In particular, please note carefully the following excerpt from this page.

The School of Mathematics and Statistics expects students to give solutions to problems and questions in tests, assignments and exams with the steps and arguments explained clearly and logically. You should attempt as far as possible to present your work to the same standard of exposition as given in lectures, notes and text books.

The timetable for assessment is given below.

Task	Details	Weight
Class test 1	Week 4	15%
Short assignment	due Friday 5p.m. week 7	10%
Class test 2	Week 11	15%
Final examination	scheduled by the University	60%

You should keep all marked assessment tasks until the end of semester in case an error has been made in recording the marks. Your marks will be available online, and you should check these well before the end of semester.

Mathematical writing and the short assignment. In all the assessment tasks, marks will be awarded for correct working, logical setting out, appropriate explanations and presentation, not just on the final answer. The aim of this is to develop your ability to present your mathematics in a professional way. Students should pay attention to neatness, grammar, clarity of argument, use of notation and so forth.

The short assignment will give students an opportunity to gain feedback on their mathematical writing. The assignment may be prepared in the mathematical typesetting language L^AT_EX, but this is not compulsory.

Class tests. The class tests will be held at the beginning of the Wednesday lecture in weeks 4 and 11, and will last about 45 minutes. They are designed to give you a chance to assess your mastery of the course material, including both the theoretical and computational aspects of the course. Marks will be awarded for correct working, logical setting out and appropriate explanations and not just the final answer. Announcements will be made in lectures about the topics that are examinable.

Normal exam conditions apply in tests. In particular, you must bring writing paper, pens, a stapler and your student card to each test, you must not consult any kind of written material during the test, and you must not try to get assistance from or give assistance to any other person. You will not be allowed to use a calculator in class tests.

If illness (or some other circumstance beyond your control) affects your attendance at or performance in the class test do not make an official application for Special Consideration, just show a medical certificate (or other documentation) to the lecturer in charge. Your mark for that test will then be based on your marks for the assignment and the final exam.

Final exam. The final two-hour exam is the major assessment task; its purpose is to determine the level of student mastery of both the theoretical and computational course material. You may bring a UNSW approved calculator to the exam, so long as it carries a UNSW sticker which shows that the calculator has been checked. These stickers may be obtained from the School of Mathematics and Statistics Office, and other Faculty Student Centres or Schools. See www.maths.unsw.edu.au/currentstudents/exam-information-and-timetables for a link to the list of approved calculators.

Resources for students. 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.

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)

Practice problems will also be available on Moodle.

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.

- As a result of feedback from 2006 we have increased the in-session assessment component, which was previously 20%.
- As a result of feedback from 2009 we have added some examples of true/false questions to Problem Sheet 1.
- As a result of feedback from 2014 we have adopted the standard convention of using boldface symbols for vectors.

Administrative matters.

Additional assessment. For the School of Mathematics and Statistics policies on additional assessment, go to www.maths.unsw.edu.au/currentstudents/special-consideration-illness-misadventure.

School rules and regulations. Fuller details of the rules regarding attendance, release of marks, special consideration etc. are available via the School of Mathematics and Statistics web page at www.maths.unsw.edu.au/currentstudents/assessment-policies.

Plagiarism and academic honesty. Plagiarism is the presentation of the thoughts or work of another as one's own. Issues you must be aware of regarding plagiarism and the University's policies on academic honesty and plagiarism are at student.unsw.edu.au/plagiarism and my.unsw.edu.au/student/academiclife/Plagiarism.pdf.

Syllabus. To be chosen from the following list. Note that topics in this syllabus which have significant overlap with first year linear algebra will be treated very briefly. We expect you already to be proficient in all aspects of MATH1241 Algebra (or equivalent); if you are not, you should probably be taking MATH2501 instead of MATH2601.

- (1) Introduction abstract algebra: groups, fields, subgroups, isomorphism.
- (2) Vector spaces, subspaces, bases, dimension, coordinates, sums and direct sums. Linear transformations and matrices, kernels and images, isomorphisms, change of basis, similarity.
- (3) Orthogonality, inner product spaces, norms, projections, Gram–Schmidt algorithm, adjoints, QR factorisation, least squares, Householder algorithm.
- (4) Permutations, cycles and determinants.
- (5) Eigenvalues and eigenvectors, diagonalisability, spectral theorems, complexification. Applications: quadratic forms, rotations and reflections, singular value decomposition.
- (6) Triangularisation, Cayley–Hamilton Theorem, minimal and characteristic polynomials, decomposable linear maps, generalised eigenspaces, Jordan forms.
- (7) Exponentials of matrices, applications to differential equations.