COURSE OUTLINE

MATH2601
HIGHER LINEAR ALGEBRA

Semester 1, 2015
MATH2601 – Course Outline

Course Authority and lecturer: A/Prof Catherine Greenhill
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Consultation hours: will be announced when my timetable is firm and will be available via Moodle.

Credit: 6 Units of Credit (6UOC).

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

Exclusions: MATH2501.

Lectures: Lectures are scheduled as follows:

Tuesday 10:00–12:00 Red Centre Theatre
Friday 13:00–15:00 CLB-5

Lectures run Weeks 1 - 12.

Tutorials: There will be one tutorial per week: you have probably already enrolled in one of the following:

Tuesday 16:00–17:00 RC-3085
Friday 9:00–10:00 RC-2061
Friday 10:00-11:00 RC-3085


About this course. This 6UOC course is the Higher version of the core second year mathematics topic, Linear Algebra MATH2501. 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.

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 significant amount of extra, theoretical material compared to MATH2501. Apart from the extra understanding that this brings, the reward for this 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 traditionally very high (as it should be with the quality of students in the 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 the 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 a fixed method 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, applying yourself in tutorials and working through the tutorial exercises prior to the tutorial, 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 the tutorial problems prior to the tutorial.

*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.

Note-taking is an important skill to learn. While skeleton lecture notes will be made available, the proofs and examples are left blank for students to fill in during lectures.

**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 [http://www.maths.unsw.edu.au/currentstudents/assessment-policies](http://www.maths.unsw.edu.au/currentstudents/assessment-policies)

The timetable for assessment is given below: *(NOTE: Test 1 moved from Week 5 to Week 4 to avoid clashes with Good Friday.)*

<table>
<thead>
<tr>
<th>Task</th>
<th>Details</th>
<th>Weight</th>
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</thead>
<tbody>
<tr>
<td>Tutorial test 1</td>
<td><strong>Week 4</strong></td>
<td>10%</td>
</tr>
<tr>
<td>Short assignment</td>
<td>due last lecture in Week 8</td>
<td>5%</td>
</tr>
<tr>
<td>Tutorial test 2</td>
<td>Week 11</td>
<td>10%</td>
</tr>
<tr>
<td>Exam</td>
<td>scheduled by the University</td>
<td>75%</td>
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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 the 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 \LaTeX, but this is not compulsory.
Tutorial tests. The class tests 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. The tests will last about 40 minutes. 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 your student card to each test, you must not bring any kind of written material into 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 appropriate documentation) to your lecturer or tutor. Your mark for that test will then be based on your marks for the assignment and the final exam.

Final exam. The final three-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. A link to the list of approved calculators can be found at http://www.maths.unsw.edu.au/currentstudents/exam-information-and-timetables

Resources for students.

Books. There is no set textbook and no one book covers all the course. The lectures 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 (P 512.86/27)
- *Linear algebra* by J.B Fraleigh. and R.A. Beauregard (P 512.897/184)
- *Linear algebra* by M. O’Nan and H. Enderton (P512.5/239)

Lecture notes. Skeleton lecture notes will be available via Blackboard.

Problem sets and past exams. Tutorial problem sheets and some past exam papers will be available via Blackboard.

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 from 20% to 25%.
- 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. See additional handout or
http://www.maths.unsw.edu.au/currentstudents/additional-assessment

School rules and regulations. Fuller details of the general rules regarding attendance, release of marks, special consideration etc. are available via the School of Mathematics and Statistics web page at
http://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 can be found at
http://www.lc.unsw.edu.au/plagiarism and
http://my.unsw.edu.au/student/academiclife/Plagiarism.pdf

Syllabus.


(2) Vector spaces, subspaces, bases, dimension, coordinates, sums and direct sums, matrix algebra, vector spaces associated with a matrix, standard forms and equivalence relations.

(3) Linear transformations and matrices, systems of linear equations, kernels and images, isomorphisms, change of basis, similarity.

(4) Revision of geometry of $\mathbb{R}^n$, length and angle in $\mathbb{C}^n$, inner product spaces, norms, projections, orthonormal bases, Gram-Schmidt algorithm, orthogonal complements, adjoints, hermitian (symmetric), unitary (orthogonal) transformations and matrices, $QR$-factorisation, least squares.

(5) Traces and determinants, eigenvalues and eigenvectors, eigenspaces, characteristic polynomial, diagonalizability, normal matrices. Applications: rotations and reflections, singular value decomposition.

(6) Canonical forms: triangularisation, Cayley-Hamilton Theorem, minimal and characteristic polynomials, direct sum decompositions, generalised eigenspaces, Jordan forms.

(7) Functions of matrices, exponentials of matrices, applications to differential equations.