



FACULTY OF SCIENCE
SCHOOL OF MATHEMATICS AND
STATISTICS

MATH2501 LINEAR ALGEBRA

Semester 1, 2017

MATH2501 – Course Outline

Information about the course

Course authority. P.G. Brown, peter@unsw.edu.au, Red Centre 5106.

Lecturers: Dr. L. Zhao - Weeks 1-6 l.zhao@unsw.edu.au, Red Centre 4106.

P.G. Brown -Weeks 7-12 peter@unsw.edu.au, Red Centre 5106.

Consultation. Preferred consultation times will be announced early in semester.

Credit, Prerequisites, Exclusions. This course counts for 6 Units of Credit (6UOC). The prerequisite for enrolling in this course is MATH1231 or MATH1241 or MATH1251. Exclusions: MATH2099, MATH2509, MATH2601.

Students with good academic records should consider taking MATH2601 Higher Linear Algebra instead of MATH2501.

Lectures. There will be four hours of lectures each week from week 1 to week 12: Monday 3pm–5pm in Webster Lecture Theatre A and Wednesday 3–5pm in Webster Lecture Theatre A.

Tutorials. There will be one tutorial per week, beginning in week 2. Times available are Tues 10–11am, Tues 4–5pm, Wed 11–12am and Thurs 2–3pm.

Web. Further information, lecture notes, problems and other material will be provided via moodle.telt.unsw.edu.au.

Course aims

This course aims to examine key ideas in linear algebra. Students will improve and develop their analytical thinking skills and their ability to communicate technical arguments clearly. Material on vector spaces and related topics which was introduced in MATH1231, MATH1241 or MATH1251 will be revised and understood in greater depth. We shall introduce more advanced work in this area including applications to geometry, data fitting and differential equations.

Relation to other mathematics courses

Mathematics may be divided into the broad categories of analysis (calculus), algebra, geometry and logic. This subject fits into the algebra category and follows on from material you will have learned in first year algebra. This course is a 6UOC course that forms part of the core second year program in pure mathematics. It is recommended for all students intending to progress to third year pure mathematics and will be very useful for those majoring in actuarial studies.

Course Overview

Linear algebra is a key tool in all of mathematics and its applications. For example, the output of many electrical circuits depends linearly on the input (over moderate ranges of input), and successfully correcting the trajectory of a space probe involves repeatedly solving systems of linear equations in hundreds of variables. Linear methods are vital in ecological population models, and in mathematics itself. You have met systems of linear equations and matrices, vector spaces and linear transformations in first year Mathematics courses, without necessarily understanding all the subtleties involved. In MATH2501, you will review the material from first year, so that vector spaces and linear transformations become familiar friends rather than uneasy acquaintances. You will learn about geometric transformations: projections (which can also be viewed as least squares approximations), rotations and reflections. You will see how to view many linear transformations as being made up of “stretches” in various directions, (the diagonalisation process), and the more general Jordan form. This will allow you to calculate functions of matrices (such as the exponential of a matrix) and hence to solve systems of linear differential equations.

Student Learning Outcomes

Students taking this course will develop an appreciation of the basic concepts and problems of linear algebra and its applications to geometry and differential equations. Students will develop their research, inquiry and analytical thinking abilities. Through regularly attending lectures and applying themselves to tutorial exercises, students will develop competency in mathematical presentation, written and verbal skills.

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 and **6.** information literacy.

Teaching strategies underpinning the course

Abstract mathematics of the type presented in this course can only be learned by actually doing it. Teaching components of the course will include not only lectures and tutorials but also tutorial problems and assessment tasks. The lectures will provide both a first introduction to the concepts and an important model of how mathematics is structured and communicated.

A central purpose of all the assessment tasks is to determine your level of mastery of the material covered in the lectures and the problems. You should view the class tests as an opportunity for you both to check that you are progressing adequately, and to have some of your mathematics read and reviewed by experienced eyes. The feedback obtained regarding how you structure your arguments and present your mathematics will be an important tool in developing these vital skills.

Assessment in this course will use problem-solving tasks of a similar form to those practised in lectures and tutorials, to encourage the development of the core analytical and computational skills underpinning this course.

Rationale for learning and teaching strategies

We believe that effective learning is best supported by a climate of enquiry, in which students are actively engaged in the learning process. To ensure effective learning, students should participate in class as outlined below.

We believe that effective learning is achieved when students attend all classes, have prepared effectively for classes by carefully studying previous lecture notes, in the case of lectures, and, in the case of tutorials, by having made a serious attempt at doing for themselves the tutorial problems prior to the tutorials.

Furthermore, lectures should be viewed by the student as an opportunity to learn, rather than just copy down lecture notes.

Effective learning is achieved when students have a genuine interest in the subject and make a serious effort to master the basic material.

The art of logically setting out mathematics is best learned by watching an expert and paying particular attention to detail. This skill is best learned by regularly attending classes.

Assessment

Assessment in this course will consist of three class tests (worth 10% each) and a two-hour final examination (70%).

MATH2501 or MATH2601? The final marks in MATH2501 will be scaled with reference to final marks in MATH2601, taking into consideration the greater degree of difficulty of MATH2601. As a result few, if any, High Distinction grades will be awarded in MATH2501; normally, no student will be awarded a final mark of more than 90%. For this reason, in addition to the greater depth of knowledge to be obtained, students who have obtained marks of more than 70% in first year mathematics should seriously consider taking MATH2601 instead of MATH2501.

Knowledge and abilities assessed. All assessment tasks will assess the learning

outcomes outlined above, specifically, the ability to apply the concepts discussed in class to solving simple and complex problems and the ability to communicate mathematical arguments in a coherent and logical manner.

Assessment criteria. The criteria for marking all assessment tasks will focus not only on correctness of answers, but also on correct working and appropriate explanations in solutions.

Class tests

Rationale. Class tests will provide continual assessment and feedback on the course material in a timely fashion. Feedback on these assessment tasks will help students to improve their ability to present mathematical arguments in a logical manner. We believe that it is important for students to master the material of early sections before proceeding to more advanced topics, and that getting problems right first time is creditable, but not altogether essential. Therefore students who do poorly in class tests will be given the opportunity to make a second attempt.

Class test schedule. The tests will be held in the lecture venue on Wednesday from 4pm to 5pm noon in weeks 4, 8 and 12. Calculators will be permitted in these tests.

Repeat class tests will be offered for students who are ill or who do poorly in the original tests. They will be held in the week after the original test, that is, weeks 5, 9 and 13, in Webster Lecture Theatre A. The repeat tests in weeks 5 and 9 will be held from 8am to 9am on **Wednesday**, that in week 13 from 4pm to 5pm on **Wednesday**. The following rules will apply.

- The topics examinable for the repeat test will be the same as for the original test. However within these topics, different questions may be asked.
- Students who sit the original test and receive a mark of less than 14 out of 20 may sit the repeat test. The repeat will be marked out of 20, but the recorded mark will be capped at 15.
- Students who miss the original test and have a reasonable excuse (e.g., medical) must sit the repeat test, and may get any mark up to 20.
- Students who miss the original test and do not have a reasonable excuse must sit the repeat test, but may only get up to 16 marks.
- If a student's mark on the repeat test is worse than on the original test, the previous mark will count.

Note that medical certificates will **not** be accepted as an excuse for missing class tests unless they cover both the original and the repeat test. Even then, further arrangements may be made to take a test later in the semester.

Examination

Duration. Two hours.

Rationale. The final examination will assess student mastery of the material covered in the course.

Weighting. 70% of your final mark.

Further details about the examination will be available in class closer to the time.

Additional resources and support

Tutorial Exercises

Sets of tutorial exercises will be available on Moodle. These problems are for YOU to do to enhance mastery of the course. Problems of similar types will be done in tutorials, but you will learn a lot more if you try to do the problems yourself before the tutorial.

Videos

A small selection of tutorial questions have an associated video solution on UTube. This can be accessed from Moodle.

Lecture material

Lecture material will be available through Moodle. Please bring a hard (or soft) copy to all lectures. **Note** that some sections of these notes, particularly those parts which are revision of first year, will consist of exercises to be worked through in lectures, and not of detailed theoretical exposition. It is therefore unlikely that these notes will be useful for individual study. In the case of the second half of the course, only skeleton notes will be provided. Gaps in these notes will need to be completed in lectures. Hence, you will need to attend lectures if you wish to get a complete set of lecture notes. Completed notes will NOT be posted. If you are genuinely ill for a lecture, then I can make a photocopy for you of the missing material if you come and speak to me in person.

Textbooks

There is no set textbook for this course and we shall not produce a coursepack, but the following references may be useful.

- First year algebra notes.

- J.B. Fraleigh and R.A. Bearegard, “Linear Algebra”, Addison–Wesley, 3rd edition, 1995.
- H. Anton and C. Rorres, “Elementary Linear Algebra with Applications”, Wiley, 9th edition, 2005 (and earlier editions).
- Many texts with titles like “An Introduction to Linear Algebra” or “Elementary Linear Algebra” will prove useful. Have a look on the library shelves at call numbers around 512.5 to see what you can find.

Moodle

Lecture notes, problems, solutions to and comments on class tests, and other material will be made available through Moodle. You should check regularly for new materials.

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. It is common practice to discuss informally with students how the course and their mastery of it are progressing.

Administrative matters

Additional Assessment

See 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 www.maths.unsw.edu.au/currentstudents/help-students-undergraduate.

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 www.lc.unsw.edu.au/plagiarism.

Syllabus in brief

It is intended that the following topics will be covered in the given order. Any variation from this will be indicated by the lecturer.

1. Linear equations and matrices.
2. Vector spaces.
3. Linear transformations.
4. Inner products, orthogonalisation and projections, QR factorisations, reflections.
5. Determinants.
6. Eigenvalues and eigenvectors.
7. Orthogonal transformations.
8. Symmetric matrices and quadratic forms, canonical forms for conics and quadrics, principal axes, diagonalisation of a quadratic form by completing the square and Sylvester's Law of Inertia.
9. The Cayley–Hamilton Theorem.
10. Jordan forms.
11. Functions of matrices.
12. Systems of ordinary differential equations.