FACULTY OF SCIENCE

SCHOOL OF MATHEMATICS AND STATISTICS

MATH2501 LINEAR ALGEBRA

Term 2, 2021

Contents

Course summary

Lecturers

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Course Authority: Dr Denis Potapov

Consultation Preferred consultation times will be announced early in term.

Credit: This course counts for 6 Units of Credit (6UOC).

Prerequisites: The prerequisite for enrolling in this course is MATH1231 or MATH1241 or MATH1251.

Exclusions: MATH2099, MATH2509, MATH2601.

Lectures: The lectures will be held on weeks 1 to 10. Please look for the time and location of each class on Moodle.

Tutorials: The tutorials begin in week 1. Tutorial problem sheets will be posted on Moodle. You should attempt the problems before attending your tutorial.

About this course

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.

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.

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

UNSW assesses students under a standards based assessment policy. For how this policy is applied in the School of Mathematics and Statistics see

http://www.maths.unsw.edu.au/currentstudents/assessment-policies

Assessment components

All students are required to complete the following assessment tasks

Test 1 (online quiz + class test)	week 4	6% + 10%
Test 2 (online quiz + class test)	week 7	6% + 10%
Test 3 (online quiz + class test)	week 10	6% + 10%
Examination	Exam period	52%

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.

Test 1 covers the topics of lectures of **weeks 1–3**; Test 2, covers the topics of lectures of **weeks 4–6**; and Test 3, covers the topics of lectures of **weeks 7–9**.

Each test will have two components: *Online Quiz* and *Class Test*:

Online Quiz Each online quiz will be available on Maple.TA throughout the week of the test (from Monday to Friday). You will have unlimited number of attempts with each quiz. The quiz result is the result of your best attempt.

Class Test Class Test question sheet will be published on Moodle in a dedicated section at the scheduled time (announced on Moodle).

You are required to be online at that time at your home or any other location which you find suitable.

You will have **60 minutes** to complete your test paper.

You will need to scan (or take photo) of every page of your workings and upload it to Moodle within 60 minutes timeframe.

There will be an active "Virtual Classroom" session (which coincides with lecture time) where an academic will be preset to respond to any questions you may have in relation to test paper.

Further details about class test arrangements are published on Moodle.

Examination

The final exam is the major assessment task. Its purpose is to determine the level of student mastery of both the theoretical and computational course material. The duration of the final exam will be two hours.

Further details about the examination will be available on Moodle closer to the time.

Special Consideration and additional assessment

If your attendance at, or performance is affected by circumstances beyond your control, you may be able to apply for special consideration. See the links below for further details.

https://www.maths.unsw.edu.au/currentstudents/special-consideration-illness-misadventure

https://www.maths.unsw.edu.au/currentstudents/additional-assessment.

Resources for Students

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 youtube. 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: 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. Beauregard, "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

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.