THE UNIVERSITY OF SYDNEY
MATH2061 LINEAR MATHEMATICS and VECTOR CALCULUS
Unit of Study Information, Semester 1 2020

MATH2061 consists of two separate modules – Linear Mathematics and Vector Calculus. Linear mathematics will be taught in the first half of the semester, and vector calculus in the second half.
In each module, you attend 3 lectures, one practice session and one tutorial each week.
The **lectures** will present the material covered in this unit. Examples and applications of the theory will also be discussed.
In the **practice sessions**, some material from first year mathematics will be revised, and additional examples will be discussed. These examples will be designed to reinforce the important ideas presented in that week's lectures. Many of the examples will be similar to those you will be asked to attempt in the tutorial session in the following week.
During the **tutorials** you will be expected to work on the supplied problem sets. Your tutor will give you help where needed. You are strongly encouraged to work in a small group in the tutorial, and to discuss the problems with fellow students.

Web Site
The MATH2061 home page:

`http://www.maths.usyd.edu.au/u/UG/IM/MATH2061`

You should check the page regularly, since important announcements relating to the unit will often be posted there. You should obtain the practice session questions, tutorial exercise sheets and assignment questions from this page, as they become available.
You should also check the Intermediate Mathematics web page

`http://www.maths.usyd.edu.au/u/UG/IM`

regularly, for any announcements relating to intermediate mathematics in general.
Email enquiries specific to this unit should be sent to `MATH2061@sydney.edu.au`.
General enquiries relating to second year mathematics should be sent to
`pm2.maths@sydney.edu.au` or `am2.maths@sydney.edu.au`.

MATH2061 LINEAR MATHEMATICS

Lectures

The linear mathematics lectures run for 6 weeks, finishing on Wednesday 3 April 2019. There are 2 different lecture streams. You should attend the lecture stream (three hours per week) shown on your personal timetable.

Times	**Location**	**Lecturer**
Stream 1: 8am Mon & Tues & Wed	Carslaw 159	Dr N Brownlowe
Stream 2: 1pm Mon & Tues & Wed	Chemistry LT 3	Prof L Paunescu

Consultation times

Lecturers are available for consultation as follows:

Prof Laurentiu Paunescu:	Mondays 2–3pm, Carslaw 721
Dr Nathan Brownlowe:	Mondays 3–4pm, Carslaw 532

Note: If you are unable to make those consultation times, we will be happy to make an alternative arrangement with you.

Practice sessions

You should attend the practice session shown on your personal timetable. Practice sessions run for 6 weeks, starting in week 1. The examples to be discussed in the practice session in week n will be posted on the web by Monday of week n. You should print out the examples and take them with you to the practice class.

Tutorials

Tutorials (one per week) start in week 2, and run for 6 weeks. The final tutorial for this module will be in week 7. Attendance at tutorials is essential as your preparation for the tutorials will contribute to your assessment. You must attend the tutorial given on your personal timetable, since your preparation cannot be recorded in a tutorial in which you are not enrolled. Tutorial sheets will be available from the MATH2061 website. You must print out and take each week's tutorial sheet with you to your class. Solutions to week n tutorial questions will be posted on the web by Monday of week $n + 1$.

Course Notes

Course Notes for Linear Mathematics by J. Henderson, are available from Kopystop, 55 Mountain Street, Broadway. It is also recommended that you have *"the little blue book"*, which is a compact reference book containing a summary of information from first year mathematics that is essential for many second year mathematics courses. This is available from the Co-op Bookshop on campus.

Reference books

Anton and Busby, *Contemporary Linear Algebra*. Wiley.
Anton, H., and Rorres, C. *Elementary Linear Algebra; applications version* , Wiley.
Lay, David C. *Linear Algebra and its Applications*, 2nd Edition. Addison Wesley.
Leon, Steven J. *Linear Algebra with Applications*, 6th Edition. Prentice Hall.
Noble, B. and Daniel, J. *Applied Linear Algebra*, 3rd Edition. Prentice-Hall.
Strang, G., *Linear Algebra and its Applications*, 3rd Edition. Harcourt Brace Jovanovich.

Assessment

Each module will be assessed separately. Your final raw mark for the module Linear Mathematics will be calculated as the sum of your marks for the examination (60%), the quiz (30%), the assignment (5%) and tutorial preparation (5%).

Examination – worth 60%.

There will be an examination at the end of Semester 1. More information relating to the exam will be provided later in the semester.

Quiz – worth 30%.

The quiz will be held during your practice session on **Thursday 4 April 2019**.

Tutorial Preparation Mark – worth 5%.

Rolls will be kept in tutorials, and you will receive one mark for each tutorial (up to a maximum of 5 marks) for preparation (that is, making a significant attempt on the preliminary exercises *before the tutorial*, not just attending). Your tutor will award the mark when he or she is satisfied that you have prepared appropriately.

Assignment

One assignment will be marked, and will be worth 5% your final raw mark. The assignment will be **due on Monday 25 March 2019**. Please note that the maximum possible **extension for the assignment is 7 days** (including the weekend). The assignment **must be scanned/imaged and submitted** in PDF format online via LMS (https://elearning.sydney.edu.au/) with **Turnitin**. Please ensure your submitted pdf is legible, not upside down or sideways, and keep your original version.

WHAT IS LINEAR MATHEMATICS ABOUT?

Linear mathematics is one of the foundations of modern mathematics. It is important theoretically because so many apparently different processes in the natural world have the same *linear structure* – they are *vector spaces*. In addition, many non–linear processes are often so complicated that they are modelled by linear approximations as a first step towards their understanding. Numerical solutions to many linear problems can be found quickly and accurately, using the theory that is at the heart of this course. We will study the beginnings of vector space theory and discuss some of the applications.

Preparatory work

The prerequisite for this module is any one of the first year linear algebra units of study (MATH1002, MATH1902 or MATH1014). You should revise the following topics from that unit: equations of lines and planes in space, the solution of systems of linear equations, reduced row echelon form of a matrix, the calculation of eigenvectors and eigenvalues for 2×2 and 3×3 matrices.

Objectives

∗ To introduce the basic concepts of vector spaces.
∗ To demonstrate how abstract theory can be applied to concrete problems in science and engineering.
∗ To develop logical thinking and the ability to analyse mathematical arguments.
∗ To enhance your problem-solving abilities.

Outcomes

At the end of this unit of study, students should be able to:
∗ solve a system of linear equations,
∗ apply the subspace test in several different vector spaces,
∗ calculate the span of a given set of vectors in various vector spaces,
∗ test sets of vectors for linear independence and dependence,
∗ find bases of vector spaces and subspaces,
∗ find a polynomial of minimum degree that fits a set of points exactly,
∗ find bases of the fundamental subspaces of a matrix,
∗ test whether an $n \times n$ matrix is diagonalisable, and if it is find its diagonal form,
∗ apply diagonalisation to solve recurrence relations and systems of DEs.

Intended weekly outline

- Week 1: Linear systems, Gaussian elimination, vector spaces, Subspaces.
- Week 2: Subspaces, linear combinations, span,linear dependence and independence.
- Week 3: Linear dependence and independence, span, basis and dimension.
- Week 4: Basis and dimension, Lagrange interpolation, column space, null space, rank, nullity, linear transformations.
- Week 5: Eigenvalues and eigenvectors, diagonalisation theorem, Leslie population model.
- Week 6: Recurrence relations, systems of linear differential equations.

For best results and maximum enjoyment in this unit of study, you should make every effort to attend all the lectures, practice sessions and tutorials. Do as many problems as you can, and make sure you work through the solutions to the tutorial exercises each week. To extend your knowledge, see the list of reference books. Read over your own notes as well as the printed lecture notes, think deeply about the new definitions and ideas, and come with your questions to consultation times.
Lectures in the vector calculus component of MATH2061 begin in week 7. Information relating to that component will be made available at the beginning of semester. You will be able to buy the "Course Notes for Vector Calculus" *by S Britton and K-G Choo, from Kopystop when you buy the Linear Algebra notes.*