**MA500-1 Advanced Linear Algebra**
SEMESTER 1 2016-17 COURSE OUTLINE

LECTURER: Dr Rachel Quinlan
Room ADB-G007, Ground Floor Áras de Brún
(091) 493796 (Extension 3796 from inside NUI Galway)
rachel.quinlan@nuigalway.ie
http://www.maths.nuigalway.ie/~rquinlan

LECTURES: Monday 11.00, Tuesdsay 11.00, Wednesday 12.00, all in ADB-1020
COURSE WEBSITE: http://www.maths.nuigalway.ie/~rquinlan/linearalgebra

## SYLLABUS

This course is an exploration of some topics in linear algebra, mostly from an algebraic/combinatorial viewpoint. Linear algebra is a vast subject that pervades virtually all areas of mathematical work including (for example) algebra, analysis, geometry, coding theory, differential equations, numerical analysis, computational mathematics and mathematical modelling.

We will be mostly thinking about the spectrum (or list of eigenvalues) of a square matrix. We will focus particular attention on connections with graph theory, which are plentiful and remarkable. We will explore some topics from the subject of *spectral graph theory*, which is about how the spectrum of a matrix associated to a graph is related to combinatorial properties of the graph itself. That there should be anything at all to say on this subject is not obvious, since the matrices in question typically arise just from tabulating the graph data and not necessarily as objects of algebraic interest at all.

We will also discuss some classical highlights of matrix theory and some of their implications, for example

- The Cauchy Interlacing Theorem
- The Perron-Frobenius Theorem
- The Geršgorin Circle Theorem(s)
- The Singular Value Decomposition.

## BACKGROUND

Familiarity with the basic mechanisms of matrix algebra (matrix multiplication, determinants, inverses, eigenvalues, etc) is expected, as well as knowledge of the essential concepts of abstract linear algebra (vector space, linear independence, spanning set, basis, dimension, linear transformation). Some experience in elementary graph theory would probably be helpful but it is not essential. If you have any doubts about whether your background in these areas is sufficient, please consult the lecturer.

## COURSE STRUCTURE

The lecture notes will be posted in instalments on the website as the course proceeds. They constitute the "text" for the course. The lecture time will be used to discuss the central themes and important questions and not to read every detail of the notes. There will be a series of three or four homework assignments as the course proceeds. We can use some of the lecture time to talk about the homework problems.

## ASSESSMENT

The set of homework assignments will account for 30% of the marks.
The two-hour final exam in the Winter exam session will account for 70% - more details on that later.

## SUPPLEMENTARY READING

You will find many books on linear algebra in the library, including the following which might be relevant to your work on this course. Wikipedia also has very good pages on many of the concepts of linear algebra that we will be discussing.

- *Elementary Linear Algebra*, Blyth and Robertson
- *Matrix Analysis*, Horn and Johnson
- *Matrix Theory*, Zhang
- *Algebraic Graph Theory*, Godsil and Royle
- *Spectra of Graphs*, Brouwer and Haemers, free at `https://www.win.tue.nl/ aeb/2WF02/spectra.pdf`