Math 520 - Linear Algebra

Brown University
Spring 2008

	Section 1	**Section 2**	**Section 3**
Time	MWF 10:00-10:50am	MWF 12:00-12:50pm	MWF 1:00-1:50pm
Location	157 Barus & Holley	115 MacMillan	168 Barus & Holley
Instructor	Xiao Xiao	David Dumas	Constanze Liaw
email	Xiao_Xiao@brown.edu	ddumas@math.brown.edu	conni@math.brown.edu
Office Hrs.	Mon 2-4pm 016 Kassar	Mon 2-3pm, Wed 3-4pm 114 Kassar	Mon 12-1pm, Wed 2-3pm 018 Kassar

1. General Information

Textbook *Introduction to Linear Algebra*, Third Edition, by Gilbert Strang

Web page http://www.math.brown.edu/~ddumas/math520/

The course web page is the primary source for information about Math 520. In particular, homework and reading assignments will be posted there.

Important Dates	Exam 1	Tues, Feb 26, 7-8pm
	Exam 2	Tues, Apr 8, 7-8pm
	Final Exam	Tues, May 13, 2-5pm

Lectures will continue through reading period. The last lecture is Monday, May 5.

2. Course Overview

This course is an introduction to vector spaces, matrices, and linear transformations. We will cover most of chapters 1–7 in the textbook, and part of chapter 8.

We will start by studying systems of linear equations. Using matrix operations, we will develop a systematic way to determine whether a system of equations has a solution, and to find all possible solutions.

We will then study geometry in vector spaces, generalizing familiar notions like distances and angles to an arbitrary number of dimensions. Least-squares fitting problems provide a natural set of applications for these ideas.

A matrix often has a set of vectors on which it acts in a particularly simple way—its *eigenvectors*. We will develop a procedure to find these vectors and numbers associated with them, the *eigenvalues*, which together make it easy to understand the action of the matrix on any vector.

Finally, we will connect our discussion of matrices with the abstract idea of a *linear transformation* acting on a space of vectors. Using this notion, matrix techniques can be applied to a wider range of mathematical and scientific problems, and we will discuss several of these.

3. Topics

The following is an approximate chronology of the course. While the last major topic is a collection of applications of linear algebra, some applications will be discussed at other times during the semester.

(1) Solving Systems of Linear Equations
- Elimination and substitution as matrix operations
- Matrix multiplication and its properties
- Matrix inverses, how to find them, when they exist
- Elimination as a factorization of a matrix (LU and LDU)
- Permutation matrices and transposes

(2) Vector Spaces, Subspaces, and Dimension
- Definition of a vector space and examples
- Subspaces of $\mathbb{R}^n$
- The Kernel or Null Space of a matrix
- Row Reduced Form and the rank of a matrix
- The general solution for a linear system
- The concept of dimension and bases for vector spaces
- Dimensions of the subspaces associated to a matrix

(3) Geometry in Vector Spaces
- Inner products and lengths, angles, orthogonality
- Projections onto subspaces
- Application: Least squares fitting
- Gram-Schmidt orthonormalization and QR factorization

(4) Determinants
- Formulas for the determinant
- Fundamental properties of the determinant
- Cofactors and the cofactor matrix
- Determinants and geometry

(5) Eigenvalues and Eigenvectors
- Definition of an eigenvalue, eigenvector
- Finding eigenvectors and eigenvalues of a matrix
- Diagonalization
- The Jordan Normal Form

(6) Linear Transformations
- Definition and examples
- The matrix of a linear transformation
- Change of basis
- Similarity and diagonalizability

(7) Applications
- Differential equations
- Linear recurrences
- Word problems, graphs
- Markov matrices

4. Grading

Your final grade for the course will be based on your homework assignments, two midterm exams, and a final exam. These components will be weighted as follows:

Homework		20%
Exam 1	Tues, Feb 26, 7-8pm	25%
Exam 2	Tues, Apr 8, 7-8pm	25%
Final Exam	Tues, May 13, 2-5pm	30%

The second midterm exam will emphasize material covered after the first exam. The final exam will cover all topics from the course, with slight emphasis on material covered after the second exam.

If you have an academic obligation (such as another exam or a course meeting) that conflicts with one of the midterm exams, inform your instructor as soon as possible. If you are absent from an exam and have not made arrangements ahead of time, you will receive no credit. Exceptions can only be made in extreme cases, such as incapacitating illness.

5. Homework Policies

Each section of Math 520 has its own homework and reading assignments. Be sure to check the right assignment listing on the course web page.

Homework will be collected weekly, usually on Friday. Late or unstapled homework will not be accepted.

The homework problems will involve material from the lectures and from the assigned reading. Do not wait until the last minute to start the homework!

Your lowest homework score will be dropped before computing your final grade.

6. Calculators

A calculator is not required in this course, and you will not be allowed to use a calculator for any of the exams.

While you are not prohibited from using a calculator while working on the assigned homework, you should do so with care, and never as a substitute for understanding. Using the linear algebra functions of advanced calculators or computer algebra systems to complete your course work is never allowed.

7. Attendance

Attending the lectures is mandatory; if you absolutely must miss a lecture, contact your instructor in advance, and make arrangements with someone in your section to get lecture notes and any other class materials. You are responsible for the contents of all lectures, including any that you cannot attend.

8. Getting Help

The following resources are available for additional help with Math 520:

- **Other students.** You are encouraged to talk to other Math 520 students about the lectures, reading, and homework assignments. (However, even if you discuss the homework with others, you must write the solutions yourself; see "Academic Honesty" below.)
- **Office hours.** Instructor office hours for each section are listed above. You can come during those times to discuss anything about the course, or make an appointment for a different time. E-mail is the best way to contact course personnel.
- **Math Resource Center.** The MRC offers walk-in help for calculus students in 105 Kassar, Monday through Thursday, 8-10pm, starting in the second week of each semester. The MRC staff consists of graduate students in math and applied math, and some advanced undergraduates. For more information, see the MRC home page: `http://www.math.brown.edu/mrc/`

9. Academic Honesty

All Brown University students must adhere to the standards of academic honesty described in the Brown Academic Code, which is available from the following URL:

`http://www.brown.edu/Administration/Dean_of_the_College/curriculum/academic_code.php`

Particularly important are the following provisions:

- The homework you submit must be your own work. You may discuss the lectures, course material, and problems with other students, but the solutions you turn in must not be copied from anyone else.
- You must not receive any unauthorized assistance on the exams.

You should refer to the academic code itself for details about these and other standards of conduct.

Suspected violations of these policies will be referred to the Standing Committee. If you are found guilty of academic dishonesty, the consequences are quite severe. Loss of credit in the course and a note on your transcript is a relatively mild but not uncommon response. Temporary or permanent separation from the university may also result.

If you have any doubt or question about any aspect of academic conduct, ask your instructor.