Matrix Algebra, Math 309, Summer 2007
Course Syllabus

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1 Instructor:

Michael (Brad) Henry
Email: mbhenry@gmail.com
Website: http://www.mbhenry.com/Math309/
Office: Cupples I, Rm 9 (in the basement)

2 Class Location and Time

Class meets every weekday from Monday, July 16 to Thursday, August 16 from 9:00 - 10:45am in Eads 112.

3 Office Hours

My office hours for this course will be scheduled on the first day of class to ensure that they meet the needs of everyone. If you need to meet with me outside of office hours, talk to me and we'll try to set something up.

4 Text

The text for this course will be *Linear Algebra: From the Beginning* by E. Carlen and M. Carvalho. This text is available at the campus bookstore.

5 Course Description

For most of you, this will be your first course in Linear Algebra (also known as Matrix Algebra). This should lead you to ask: What is Linear Algebra, and why should I care about it? This semester will be spent answering both question, but let me give a short motivating introduction to get us started.

In 2-dimensional space ("the plane"), the linear objects we care about are, well, lines! Lines are 1-dimensional objects. We can only move back and forth along a line (i.e. we have 1 dimensions worth of movement), whereas with the plane we can move back and forth and side to side. Two lines either do not intersect each other or intersect in exactly one point. Points are what we call 0-dimensional objects. In 3-dimensional space ("space"), the linear objects we care about are points, lines and planes. Two planes can intersted in a line or not at all and two lines can intersect in a point or not at all. These objects are easy to visualize and understand and we would like to build a mathematical theory that allow us to study these "linear" objects in much higher dimensions. In other words, we want to be able to understand

the higher-dimensional analogues of lines and planes: we call these objects hyperplanes. Why do we want to do this? Well, in the past you have seen that lines are an excellent way to approximate a function at a point (derivatives!) and in Multivariable Calculus you've seen that planes are an excellent way to approximate surfaces in space. In these situations, lines and planes are much easier to understand than the original objects. Studying hyperplanes will help us understand more complicated objects in much higher dimensions.

So, the answer to the first part of our original question is this: Linear Algebra is the algebraic study of hyperplanes, the higher-dimensional analogue of lines and planes. In general, we will be studying the transformations of n-dimensional space which preserves hyperplanes (i.e. linear transformations), and we will be studying the ways that these hyperplanes can intersect each other (i.e. solving systems of linear equations). Specifically, we will be investigating six core topics:

1. Linear Transformations
2. Systems of Linear Equations
3. Vector Spaces, Subspaces and Dimension
4. Orthogonality
5. Determinants
6. Eigenvalues and Eigenvectors

Every first Linear Algebra course will introduce the students to all these topics, as they are all equally important. Further, these six topics are linked by the idea of a matrix; hence, matrices are fundamental objects in Linear Algebra and we will study them extensively. That is why this class is officially called Matrix Algebra.

As for why we should care about any of this? First, Linear Algebra has a diverse number of applications. It is used by people in computer science, forestry and agriculture, physics, biology, chemistry, the social sciences, pure and applied mathematics, engineering, and more. The reason is because linear relationships are plentiful in the natural world, and when they aren't present, often you can get a good approximation to what you are looking at by changing it to a linear problem (think about tangent lines and planes in calculus!).

Second, Linear Algebra is a beautiful subject. It is filled with geometry, and the key ideas are simple and elegant (though not easy). Just like in any other human endeavor, there is a tremendous aesthetic in mathematics, and this subject is a masterpiece in many ways.

6 Course Goals

We have three main goals in this course:

- Develop the ability to solve computational problems involving any of the six topics listed above.
- Develop a conceptual understanding of why the computational procedures involved in those solutions actually work.
- Develop the ability to articulate conceptual and computational understanding verbally through weekly meetings with me and in writing through homework assignments.

In other words, we will learn how to do Linear Algebra, why it works, and how to communicate it to others.

7 Course Assessment

In this course, you will be demonstrating progress to me through homework, exams, and weekly one-on-one meetings.

1. Bi-weekly Homework Assignments:

   - Homework exercises will be assigned every day. These exercises will be a mix of computational and conceptual questions. It is absolutely essential that you work on these exercises as they are assigned. Keeping up with the homework will make the lectures more understandable and help keep the stress level from this class down. Since this class meets everyday, it is easy to become overwhelmed by the coursework. For best success you should try doing the following. Each night you should read through the sections covered in the morning lecture, work through the examples in the book, and then give the homework problems assigned a serious effort. You should make note of what material you understand and what you do not and then bring any questions to me in the next day's office hours or talk to your classmates.
   - Mathematics should be a social activity. You *should* be talking with your classmates about lectures, examples, topics, and homework exercises you are struggling with. However, it is very important you give each homework exercise a serious effort before consulting a classmate or coming to speak with me in office hours. If you do talk to a classmate about an exercise, it is important that you independently write up a solution.
   - Homework will be collected on Tuesdays and Thursdays. Homework assigned on Tuesday and Wednesday will be due on Thursdays and homework assigned on Thursday, Friday, and Monday will be due on Tuesday.

2. Exams

   - There will be two take-home exams handed out at the end of the 2nd and 4th weeks (Friday, July 27 and Friday, August 10). These will be due on the Monday after they are assigned (Monday, July 30 and Monday, August 13). You may use your textbook, your course notes, and previous homework assignments on these exams. **You may not use any other sources for these exams.** This includes other books, your classmates, the Internet, strangers you meet on the street, or any other outside sources. Each exam will include an Honor Code statement which you must sign. Please refer to the Academic Integrity section at the bottom of the syllabus for a link to the Washington University Academic Integrity Policy.
   - There will be a cumulative final exam on the last day of class (Thursday, August 16). This will be an in-class exam.

3. Weekly One-on-One Meetings:

   - Once a week, each of you will meet with me for 20-30 minutes to discuss recent material covered in class. The goal of these meetings is for you to learn how to verbalize your understanding of the concepts from class. I will let you choose a homework question from the previous few days which you will present to me. You should explain both the computational tools used to solve the problem and the mathematical concepts underlying the tools. Then I will select another homework question for you to present in a similar manner.
   - We will develop a meeting schedule for each of you on the first day of class. If you are not able to make one of your meetings, please let me know as soon as possible and we will try to reschedule. There will not be a meeting during the last week of class.

No late homework or take-home exams will be accepted. However, you will be allowed to drop your lowest homework grade.

8 Course Grades

Grade Scale:

A	90 - 100
B	80 - 89
C	70 - 79
D	65 - 69
F	< 65

Grade distribution:

Homework	25 %
Weekly Meetings	15 %
Take-home Exam 1	15 %
Take-home Exam 2	15 %
Final Exam	30 %

9 Academic Integrity

You are expected to follow the academic integrity standards of Washington University as posted at:

http://artsci.wustl.edu/~college/Policies/