Math 39000: Linear Algebra II, with applications (Course No: 29734)

Meets: MW 1:30-2:45p in BS 3014
Final Exam: May 5, 1:00-3:00p

Instructor: Carl Cowen **Office:** LD 224P **Phone:** 278-8846
Office Hours: M 10:30-11:30a and 3:00-4:00p, W 10:30a - 12:30p, or by appointment
E-mail: ccowen@iupui.edu
URL: http://www.math.iupui.edu/~ccowen/Math390.html

Linear algebra is second only to calculus in terms of importance for applications. In many applications, the problem is formulated mathematically, it is then converted to a linear algebra problem (possibly without the user knowing it), the linear algebra problem is solved using a computer, and, finally, the results are interpreted. For example, many numerical routines for solving differential equations change the problem into a linear algebra problem first.

This is a mathematics course: We will develop the mathematics with theorems and their proofs. The course also includes several important applications in which we will create a mathematical model, prove theorems that lead to the solution of problems in the model, and interpret the results. Throughout the course, we will remain conscious of the reliance on computers for real world computation, and there will be a formal computer component to the course. Most homework and test questions will be designed for paper and pencil computation, but you will be permitted (encouraged!!) to do your homework using a machine. You will be able to use *Matlab* software, capable of doing all the numerical computations required for the course, on many of the UITS machines on the IUPUI campus, including the lab on the second floor of LD. It is planned that the second mid-term test, the final exam, and possibly the first mid-term test, will be held in a computer laboratory so that you will be able to use *Matlab* software if you wish. The importance of computer computation will affect the development of some of the topics for the course. In many situations in linear algebra, the obvious method is not the one used in practice because it is too prone to error or too time consuming. We will always try to indicate the practical algorithms for solving linear algebra problems, and one of the goals of the course is to make it possible for you to understand the techniques used in linear algebra software, and read the documentation for linear algebra software.

The official text will be

Text: *Linear Algebra for Engineering and Science,*

by Carl Cowen (ISBN 0-9650717-4-X)

with supplemental material for the application to cost accounting and possibly other topics. Books on reserve in the library covering some of the topics of the course are the text and:

Linear Algebra and Its Applications, by Gilbert Strang.

Linear Algebra Done Right, by Sheldon Axler.

Math 351 (or Math 511 or the equivalent) is a prerequisite for this course and I will assume you know the material from such a course. Some of the important ideas from these courses include linear independence, basis, and rank; the (ten or so) equivalent conditions

for invertibility of a matrix; inner products and the Gram–Schmidt algorithm. (Although eigenvalues and eigenvectors are usually introduced in Math 351 and Math 511, we will begin at the beginning of this topic.)

There will be two mid-term tests, each counting about 20–25% of your grade, and about 40% of your grade will come from the two–hour final exam given during Final Exam week (May 5). Weekly homework will make up the remaining 10–15% of your grade. Make-up/late homework will **not** be graded for credit.

The developing schedule for the course will be announced in class, but will also be on the website for the course, updated regularly.

My goals for you in this course are

Short term goal: That you become proficient in the language of linear algebra, as it is used both formally and informally in theoretical discussions and applications to problems from other disciplines.

Short term goal: That you develop your ability to read mathematics and learn from what you read.

Short term goal: That you develop your ability to write mathematics, especially the ability to create and clearly write proofs, which are the explanations of why things in mathematics are true.

Approximate Course Outline

Chap	*Topic*	*Lectures*
1–4	Partitioning Matrices, Review	2
5	Norms of Matrices, Efficiency & Accuracy of Algorithms	2
HO	Application: Internal Cost Allocation	2
3.7	Change of Coordinates	1
4.1	Geometry of Subspaces	1
6	Orthogonal Projections, QR Factorization	3
6	Application: Least Squares Estimation	1
	Midterm Test I (possibly in computer lab, early March)	
8	Eigenvalues, Eigenvectors, and Diagonalization	2
9	Hermitian and Normal Matrices	2
12	Application: Markov Chains	2
10	Nilpotent Matrices	1
10	Jordan Canonical Form	3
	Midterm Test II (probably in computer lab, mid April)	
10	Application: Systems of Differential Equations	2
7	Linear Transformations	2
	time permitting, topics from the following list will be chosen:	
13	Convexity	(1?)
13	Application: Introduction to Linear Programming	(2?)
HO	Gerschgorin's Theorem, Computation of Eigenvalues, Rayleigh Quotients	(2?)

Final Exam (probably in computer lab), May 5, 1:00-3:00p

Some Important Dates

Date	
January 18	Martin Luther King, Jr. Day, no classes
March 5	Last day to withdraw with adviser's signature and automatic "W"
March 15–19	Spring Break!! no classes
April 2	Last day to withdraw with permission of adviser and instructor
May 5	Final Exam, 1:00–3:00p