Math 390: Linear Algebra II, with applications (Course No: 28654)

Meets: MW 3:00-4:15 in LD 004
Final Exam: Friday, May 2, 3:30 – 5:30p

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Office Hours: MF 11:00a – 12:30p, W 10:30 – noon, or by appointment
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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, and possibly the first mid-term test and some or all of the final exam, 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 that cover some of the topics of the course include the text and:

Linear Algebra and Its Applications, by Gilbert Strang.

Linear Algebra Done Right, by Sheldon Axler.

Math 351 (or Math 511) is a prerequisite for this course and I will assume you know material in that course. Some of the important ideas from that course include linear independence, basis, and rank; the (half dozen or so) equivalent conditions for invertibility of a matrix; inner products and the Gram–Schmidt algorithm; and linear transformations and their relation to matrices. (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 one–hour 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 2).

Weekly homework and occasional quizzes will make up the remaining 10–15% of your grade. Make-up/late homework will **not** be graded for credit. Quizzes based on the homework will be announced in advance and will be the done the last ten minutes or so of the class. No make-up/late quizzes will be graded for credit; the two lowest quiz grades will be dropped, with missed quizzes counted as zeros.

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

You should show your all your work on homework and tests. Results of machine computations will be acceptable in **all** homework problems in place of hand computation; "show your work" in this case means writing down the computation you asked the machine to do and giving the result of this computation. (You should **NOT** attach a printout of your computer session unless explicitly asked to do so!) Of course, justification and explanation of your computational work as well as proofs and your work on similar exercises will need to be written in the usual way.

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.
- **Long term goal:** That you develop and sustain an excitement about mathematics and its connections to problems in the 'real world' generally, especially the mathematics you need in your professional and personal life, and that you can and do communicate that excitement to others.

General Academic Policies

The work you submit for homework, quizzes, tests, and the final exam must be your own. For homework you will probably find it beneficial to consult with other students about the material and this kind of conversation and collaboration is encouraged. At the end of the consultation, however, each participant is expected to prepare their own summary of the discussion and their own solutions to the problems. More information about student conduct can be found at

`http://registrar.iupui.edu/misconduct.html`

More information concerning adaptive services for learning or other disabilities at IUPUI can be found at

`http://life.iupui.edu/aes/`

The policies for this class will be those derived from IUPUI's policies on academic conduct and adaptive services.

Approximate Course Outline

Topic	*Lectures*
Partitioning Matrices	1
Gaussian Elimination Revisited: LU Factorization	2
Norms of Matrices	2
Efficiency & Accuracy of Algorithms	1
Application: Internal Cost Allocation	1
Geometry of Subspaces, Orthogonal Projections	4
Application: Least Squares Estimation	2

Midterm Test I ((possibly in computer lab, week 6 or 7)

Eigenvalues, Eigenvectors, and Diagonalization	2
Application: Markov Chains	2
Hermitian and Normal Matrices	1
Nilpotent Matrices	1
Jordan Canonical Form	2
Application: Systems of Differential Equations	1
Gerschgorin's Theorem, Computation of Eigenvalues, Rayleigh Quotients	2

Midterm Test II (probably in computer lab, week 13)

Convexity	1
Application: Introduction to Linear Programming	2

Final Exam (possibly part or all in computer lab, May 2)