Math 51100: Linear Algebra with Applications (Class No: 15789)

Prerequisite: Math 26100; informal knowledge of matrix operations and solution of linear equations from earlier courses in engineering and math.

Meets: MW 6:00-7:15p in SL 137
Final Exam: Wednesday, December 14, 6:00-8:00p

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Office Hours: M 3:00-4:00p, Tu 4:00-5:00p, W 1:00-2:00p, or by appointment
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General Information

This course might be subtitled "Applicable Matrix Analysis and Linear Algebra". Linear algebra is second only to calculus/differential equations in terms of mathematics of importance to engineering applications. The goal of this course is to enable you to recognize linear algebra problems when you see them and to use the linear algebra you know to solve them. Other goals are to enable you to read and understand descriptions of other people's solutions to problems that use linear algebra and to read the documentation for the linear algebra features of the mathematical software you need to use.

This is a course describing applicable mathematics. While we will occasionally mention some specific applications, direct applications are not the main focus of the course. Most of you already know or will soon learn the application material and need to better understand the tools.

Throughout, the course remains conscious of the reliance on computers for real world computation. Moreover, there is a formal computer component to the course: some homework and the tests, which will held in a computer lab, will be inconvenient to do without a machine of some kind. UITS, the School of Science, and the School of Engineering and Technology make MATLAB, an industry standard program for numerical linear algebra, available in some Macintosh and Windows labs administered by UITS for use in this course and many engineering departments have linear algebra software available on their machines. The Student Version of MATLAB is recommended; student versions for Macintosh and Windows are available for about $100 online. (*GNU Octave* is a *free(!)* numerical linear algebra package very similar to *Matlab*.) In addition, many of you have calculators that do linear algebra calculations.

The stated prerequisite, Math 26100, is accurate in spirit in that students who know absolutely nothing about linear algebra and multi-dimensional mathematics are likely to have a hard time, but is not literally accurate because many students did not do their undergraduate work at IUPUI and much of the linear algebra learning that I expect you to know will have come informally from a variety of engineering sources. The course will be complete, but basic material on computational topics such as row operations will be covered quickly.

References

TEXT: *Linear Algebra for Engineering and Science,* second preliminary edition, by Carl Cowen (ISBN 0-9650717-4-X).

Besides the official text, Strang's book *Linear Algebra and Its Applications* is a good reference and is on reserve in the library. The problems in Strang tend to be less difficult both computationally and theoretically than the text's, but Strang develops the subject very well and presents excellent intuition for the subject and its applications. Strang's book is difficult to use as a reference because it is written in a narrative style. Another book that covers the material for the course at a higher level is *Applied Linear Algebra,* by B. Noble and J. Daniel (third edition, 1988).

Grading Policies

There will be two one–hour tests, each counting about 20–25% of your grade, and about 35–40% of your grade will come from the two–hour final exam given December 14. It is expected that the two midterms and the final exam will be conducted in a computer laboratory.

Weekly homework (usually collected Wednesdays) will make up 10–15% of your grade. There will also be a few quizzes each of which will count as one homework. The lowest 3 of your homework/quiz scores will be dropped. Because of this policy, no late homeworks will be accepted and no make-up quizzes will be given except in the case of extended absence. You should show all your work on homework, quizzes, 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 **MAY NOT** attach a printout of your computer session unless explicitly asked to do so!)

General Academic Policies

There are a number of campus-wide policies governing the conduct of courses at IUPUI. These can be found at `http://registrar.iupui.edu/course_policies.html`

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. The policies for this class will be those derived from IUPUI's policies on academic conduct and adaptive services. More information about student conduct can be found at

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

All students involved in a particular event of such dishonesty will receive a zero on the item involved; a second infraction by an individual would usually mean receiving an 'F' for the course.

More information concerning adaptive services for learning or other disabilities at IUPUI can be found at `http://life.iupui.edu/aes/`

Approximate Course Outline

Topic	*Text*	*Approx. No. of Lectures*
Matrix Algebra and Systems of Linear Equations matrix operations, linear systems, elimination, row echelon form and elementary matrices, determinants	1, 2	4
Spaces, Bases, and Coordinates vector spaces, subspaces, basis, dimension, rank–nullity theorem, coordinates and change of coordinates	3	6
Inner Products and Geometry inner products, orthogonality, Gram–Schmidt (and QR), sums and intersections of subspaces, Fund. Thm. Lin. Alg.	4.1–4.4	4
Test 1 – early October		
Norms norms of matrices, infinite series	5	1
Projections and Least Squares projections, inconsistent systems, least squares, QR (via Householder)	6.1–6.3, 6.5	3
Linear Transformations linear transformations and the matrix of a transformation	7	1
Eigenvalues, and Eigenvectors eigenvectors and eigenvalues, spectral mapping theorem, matrix exponential and application to systems of ODE's, diagonalization	8	4
Test 2 – mid November		
Hermitian and Normal Matrices unitary similarity, Schur triangular form, spectral theorem for Hermitian matrices, SVD	9	2
Jordan Canonical Form Cayley–Hamilton theorem, Block Jordan Form, applications to differential equations	10.1, 10.2	2
	TOTAL	27

Some Important Dates

Date	
August 22	First Day of Classes
October 16	Last day to withdraw with adviser's signature and automatic "W"
October 17–18	October Break!! no classes
November 15	Last day to withdraw with permission of adviser and instructor
December 12	Last Day of Classes
December 14	Final Exam, 6:00–8:00p