MATHEMATICS 2270-3
Linear Algebra
Fall semester 2009

text:	*Linear Algebra with Applications,* 4^{th} *edition*, by Otto Bretscher
when:	MTuWF 10:45-11:35
where:	LCB 215

instructor:	Prof. Nick Korevaar
office:	LCB 204
telephone:	581-7318
email:	korevaar@math.utah.edu
office hours:	MW 11:45-12:30 pm, TF 9:45-10:15 am
problem session:	Th 10:45-12:05, LCB 225

course web page: www.math.utah.edu/~korevaar/2270fall09

prerequisites: Math 1210-1220, or Math 1250-1260, or Math 1270-1280; first year Calculus. Previous exposure to vectors, either in a multivariable Calculus course (e.g. 2210 or 1260 or 1280) or in a Physics course, is helpful but not essential.

course outline: This is the first semester in a year-long sequence devoted to linear mathematics. Our topic this semester is linear algebra, a fundamental area of mathematics that is used to describe and study a multitude of subjects in science and life. The origins of this field go back to the algebra which one must solve to find the intersection of two lines in a plane, or of several planes in space, or more generally the solution set of one or more simultaneous "linear" equations involving several variables.

We shall cover chapters 1-8 of the text. The detailed syllabus which follows the course summary below is an educated guess at how we will proceed, although the only things for certain are the exam dates.

The course begins in chapter 1 by studying linear systems of equations and the Gauss-Jordan method for systematically solving them. Linear algebra always has a "linear geometric" interpretation, which may have been omitted in your earlier exposure. We study aspects of this linear geometry for the Euclidean plane in chapter 2, as well as the relation between inverse matrices and inverse transformations In chapter 3 we undertake a more systematic exploration of the linear geometry related to transformations and subspaces of $\mathbb{R}^n$.

The relatively concrete concepts for subspaces of $\mathbb{R}^n$ which we discuss in chapter 3, concepts including span, independence, basis, dimension and coordinates, actually apply to many other spaces, called "vector spaces" or "linear spaces". These generalized notions have many common applications to seemingly diverse areas of mathematics, including the study of differential equations in Math 2280. So, in chapter 4 we study these notions abstractly.

You know what it means for two directions to be perpendicular, and may already have used the "dot product" to test for this condition. This notion of "orthogonality" is a major theme of linear algebra, and is the focus of chapter 5. We will study orthogonal projections and transformations, Gram-Schmidt orthogonalization, methods of least squares, notions of orthogonality for functions, Fourier series.

You have probably used determinants as a computational tool in high school algebra, but are probably not aware of all their uses and why their magic properties work. We will study determinants in detail in chapter 6, including their important geometric meaning related to oriented areas and volumes.

There are special vectors known as eigenvectors, related to the geometry of linear transformations . They also arise in the study of dynamical systems and in differential equations. Eigenvectors and eigenvalues are the topics of chapter 7. In chapter 8 we will see some initial applications of eigenvectors, related to conic sections, quadric surfaces, and the multivariable second derivative test. Finally, in section 8.3 we will discuss the singular value decomposition for arbitrary linear transformations, important conceptually and in numerical applications. In Math 2280 you will see many more applications of eigenvalues and eigenvectors.

computer projects: There will be approximately 3 computer projects during the semester, to enhance and expand upon the material in the text. They will be written in the software package MAPLE. On MAPLE days we will meet in the Math Department Computer Lab in LCB 115. We do not assume you have had any previous experience with this software and we will make the necessary introductions during the first lab project. You will also find MAPLE useful for some of your regular homework. There are many labs around campus where MAPLE is also available, for example at the College of Engineering and Marriott Library, as well as in the walk-in Math lab located down the hall from LCB 115, in the Rushing Student Center.

tutoring center: The Math Department Tutoring Center offers free tutoring for all Math courses through the 2000-level. It is located in the Rushing Student Center, in the basement between JWB and LCB. The tutoring center and the adjoining walk-in computer lab are open from 8 a.m. to 8 p.m. on M-Th, and from 8 a.m to 6 p.m. on Fridays, starting Monday August 31. Some, but not all of the math tutors welcome questions from Math 2270 students; once you find a tutor you like you should learn their available hours.

grading: There will be two midterms, a comprehensive final examination, and homework. Homework assignments and other course information will be posted on the course web page. There will also be a link on this page to WebCT, where you will be able to check your grades on homework and exams.

Each midterm will count for 20% of your grade, homework (including book and Maple assignments) will count for 30%, and the final exam will make up the remaining 30%. Homework assigned by Friday of one week will be collected the following Friday, in order that it may be partially graded. Note that in addition to the regular office hours and the tutoring center, you may attend the weekly homework problem session which I will lead, Thursdays in a LCB 225 from 10:45-12:05. Maple projects will generally be due one week after they are assigned. A homework grader will partially grade your assignments. The value of carefully working homework problems is that mathematics (like anything) must be practiced and experienced to be learned.

It is the Math Department policy, and mine as well, to grant any withdrawl request until the University deadline of Friday October 23.

ADA Statement: The American with Disabilities Act requires that reasonable accomodations be provided for students with physical, sensory, cognitive, systemic, learning, and psychiatric disabilities. Please contact me at the beginning of the semester to discuss any such accommodations for the course.

Tentative Daily Schedule

exam dates fixed, daily subject matter approximated

M	24 Aug	1.1	linear systems
T	25 Aug	1.2	matrices and Gauss elimination
W	26 Aug	1.3	solutions of linear systems
F	28 Aug	1.3	cont'd
M	31 Aug	App. A	vectors and dot product review
T	1 Sept	2.1	linear transformations and inverses
W	2 Sept	2.2,2.4	geometric interpretation
F	4 Sept	2.2-2.4	matrices and inverses
M	7 Sept	none	Labor Day
T	8 Sept	2.3-2.4	cont'd
W	9 Sept	extra	fractals
F	11 Sept	Maple I	Maple lab I, in LCB 115
M	14 Sept	3.1	kernel and image
T	15 Sept	3.1-3.2	subspaces
W	16 Sept	3.2-3.3	independence and bases
F	18 Sept	3.3	dimension
M	21 Sept	3.3-3.4	coordinates
T	22 Sept	3.4	coordinates
W	23 Sept	review	chapters 1-3
F	25 Sept	exam 1	chapters 1-3
M	28 Sept	4.1	vector spaces
T	29 Sept	4.1-4.2	and linear transformations
W	30 Sept	4.2	cont'd
F	2 Oct	4.3	matrix of linear transformation
M	5 Oct	4.3	cont'd
T	6 Oct	5.1	orthonormal bases
W	7 Oct	5.1	cont'd
F	9 Oct	5.2	Gram-Schmidt
M	12 Oct	none	fall break
T	13 Oct	none	fall break
W	14 Oct	none	fall break
F	15 Oct	none	fall break
M	19 Oct	5.3	orthogonal transformations
T	20 Oct	5.3-5.4	also projections and least squares
W	21 Oct	5.4	applications to data fitting
F	23 Oct	5.4	4 fundamental subspaces

M	26 Oct	5.5 and Maple II	inner products and Fourier series
T	27 Oct	6.1	intro to determinants
W	28 Oct	6.1	and determinant properties
F	30 Oct	6.1-6.2	cont'd
M	2 Nov	6.2-6.3	geometric meaning
T	3 Nov	6.3	cov in multiple integrals
W	4 Nov	review	4-6
F	6 Nov	exam 2	4-6
M	9 Nov	7.1	discrete dynamical systems
T	10 Nov	7.1 and extra	google example
W	11 Nov	7.2-7.3	eigenvalues and eigenvectors
F	13 Nov	7.3	cont'd
M	16 Nov	7.4	diagonalization
T	17 Nov	7.4-7.5	and similar matrices
W	18 Nov	7.5	complex numbers
F	19 Nov	7.5	and their algebra and geometry
M	23 Nov	7.5	complex eigenvectors
T	24 Nov	7.5-7.6	stability
W	25 Nov	7.6	stability
F	27 Nov	none	Thanksgiving break
M	30 Nov	8.1-8.2	symmetric matrices and applications
T	1 Dec	8.1-8.2	cont'd
W	2 Dec	8.2	cont'd
F	4 Dec	8.2	spectral theorem for symmetric matrices
M	7 Dec	8.2-8.3	singular values
T	8 Dec	8.3	singular value decomposition
W	9 Dec	review or extra	catch up day or review
F	11 Dec	review	review for final
M	14 Dec	FINAL EXAM	entire course, in class, 10:30 a.m.-12:30 p.m.