MATHEMATICS 2270-1
Linear Algebra
Fall semester 2003

text:	*Linear Algebra with Applications*, second edition, by Otto Bretscher
when:	MTuWF 9:40-10:30
where:	JTB 120
instructor:	Prof. Grant B. Gustafson
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office hours:	MWF 8:30 a.m.

course web page: www.math.utah.edu/∼gustafso/

prerequisites: Math 1210-1220, or Math 1250-1260, first year Calculus. Previous exposure to vectors, either in a multivariable Calculus course (e.g. 2210 or 1260) 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 scientific subjects. 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.

The Bretscher text used this year seems more dynamic in its presentations, compared to texts used previously. It is our intention to cover chapters 1-8. 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, and we begin studying the linear geometry of 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 other abstractions, called "vector spaces" or "linear spaces". These generalizations have many applications to diverse areas of mathematics, including the study of differential equations in Math 2280. So, in chapter 4 we study these notions in an abstract setting.

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 as used in the study of Fourier series.

Determinants are a computational tool introduced in high school algebra. We will study determinants in detail in chapter 6, including their important geometric meaning related to oriented areas and volumes.

Related to the geometry of linear transformations and coordinate systems there are special vectors known as eigenvectors. They also arise in the study of dynamical systems and in differential equations. These 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. In Math 2280 you will see deeper applications.

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 located in the South Physics building, room 205. This building lies just north of the Math Department building JWB. We do not assume you have had any previous experience with this software and we will make the necessary introductions during the first visit to the lab. **tutoring**

center: The Math Department Tutoring Center is located in Mines 210, and is open for free tutoring from 8 a.m. to 8 p.m. on M-Th, and from 8 a.m to 2 p.m. on Friday. Some, but not all of the math tutors welcome questions from Math 2270 students. To see the times and specialities of various tutors, use the web address `www.math.utah.edu/ugrad/tutoring.html` . **grading:**

There will be four midterms, computer labs and take-home exams (homework). All assignments will be posted on the course web page. The midterms count for 50% of your grade. Homework and Maple assignments will count for 50%. The book homework will be assigned daily and collected during each week. Maple projects will generally be due two weeks after they are assigned. It is the Math

Department policy, and mine as well, to grant any withdrawal request until the University deadline in mid-October.

ADA Statement: The American with Disabilities Act requires that reasonable accommodations 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

Aug 20	1.1 linear systems
Aug 22	1.2 matrices and Gauss elimination
Aug 25	1.2 cont'd
Aug 26	1.3 solutions of linear systems
Aug 26	1.3 cont'd
Aug 27	1.3 cont'd
Aug 29	2.1 linear transformations
Sep 1	Labor Day
Sep 2	2.2 geometric interpretation
Sep 3	2.3 inverses
Sep 5	2.3 cont'd
Sep 5	Maple lab I
Sep 8	2.4 matrix products
Sep 9	3.1 kernel and image
Sep 10	3.2 subspaces
Sep 12	3.2 independence and bases
Sep 15	3.3 dimension
Sep 16	3.4 coordinates
Sep 17	chapters 1-3 review
Sep 19	Exam 1
Sep 22	4.1 vector spaces
Sep 23	4.2 linear transformations
Sep 24	4.3 coordinates
Sep 24	5.1 orthonormal bases
Sep 26	5.1 cont'd
Sep 29	5.1 cont'd
Sep 30	5.2 Gram-Schmidt
Oct 1	5.3 orthogonal transformation
Oct 2-3	Holiday
Oct 6	5.3 cont'd
Oct 7	5.4 least squares
Oct 8	5.3 cont'd
Oct 8	Maple lab II
Oct 10	5.5 inner product spaces
Oct 13	Fourier series
Oct 14	6.1 intro to determinants
Oct 15	6.2 determinant properties
Oct 17	6.2 cont'd
Oct 20	6.3 geometric meaning
Oct 21	7.1 dynamical systems and eigenvalues
Oct 22	Exam 2
Oct 24	7.2 eigenvalues
Oct 27	7.3 eigenvectors
Oct 28	7.4 diagonalization
Oct 29	7.4 cont'd
Oct 31	7.5 cont'd
Nov 3	7.5 complex numbers
Nov 4	7.5 cont'd
Nov 5	Notes: Jordan form
Nov 7	Notes: Jordan form
Nov 10	7.6 stability
Nov 11	8.1 symmetric matrices
Nov 12	8.1 cont'd
Nov 14	8.2 quadratic forms
Nov 17	8.2 conics and quartics
Nov 18	8.3 singular values
Nov 19	8.3 cont'd
Nov 21	Exam III
Nov 24	Notes
Nov 25	Maple Lab III
Nov 26	Notes
Nov 27-28	Holiday
Dec 1	Exam IV
Dec 2	Maple Lab III
Dec 3	Grade reports

Exercises Week 1

1.1-1,3,5,7,11,13,15,19,25,29,37
Submit 19,25,29,37
1.2-1,3,5,7,9,11,13,15,17,19,21,27,28,31,35,42
Submit 7,19,21,27,28,31,42
1.3-1,5,13,19,21,23,25,27,29,35,37,47,55
Submit 23,25,27,29,47
Ch 1 Review: 1,3,7,11,15,19,23,27,29,35
Submit all.
2.1-1,3,5,7,9,12,13,15,17,19,21,25,27,29,33,35,39,43

Submit 5,12,13,33,39,43
2.2-1,3,5,17,21,23,31,33,37,41,43,47,49
Sumbit 17,31,33,37,43,45
2.3-3,5,13,15,19,23,27,35,37,41,42,44,45,47
Submit 15,27,31,45
2.4-3,5,9,11,13,17,27,31,33,37,39,43,45,49,53,59,63,76
Submit 13,17,31,39,45,53,63,76
Ch 2 Review: 1,3,11,14,15,21,25,27,33,39,41,45,49
Submit 3,15,25,39,41,49
3.1-3,5,9,11,13,15,17,21,23,25,29,33,37,47