**MATHEMATICS 2270-2**
**Linear Algebra**
Fall semester 2001

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| **text:** | *Linear Algebra with Applications*, second edition, by Otto Bretscher |
| **when:** | MTuWF 12:55-1:45 |
| **where:** | NS 201 |
| **instructor:** | Prof. Nick Korevaar |
| **office:** | JWB 218 |
| **telephone:** | 581-7318 |
| **email:** | korevaar@math.utah.edu |
| **office hours:** | M 2-2:50 p.m., T 9-10 a.m., W 2-2:50 p.m., Th 11 a.m - 12:30 p.m. |

**course web page:** www.math.utah.edu/~korevaar/2270fall01.html

**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 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 are trying a new text this year which seems more dynamic than the one we 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 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.

Related to the geometry of linear transformations 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 many more 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, consult the web address www.math.utah.edu/ugrad/tutoring.html .

**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.) Each midterm will count for 20% of your grade, homework Iincluding book and Maple assignments) will count for 30%, and the final exam will make up the remaining 30%. The book homework will be assigned daily and collected weekly, usually on Fridays. 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 19.

**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

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| W | 22 Aug | 1.1 | linear systems |
| F | 24 Aug | 1.2 | matrices and Gauss elimination |
| M | 27 Aug | 1.3 | solutions of linear systems |
| T | 28 Aug | cont'd | cont'd |
| W | 29 Aug | 2.1 | linear transformations |
| F | 31 Aug | 2.2 | geometric interpretation |
| M | 3 Sept | none | Labor Day |
| T | 4 Sept | 2.2-2.3 | and inverses |
| W | 5 Sept | 2.3 | inverses |
| F | 7 Sept | extra | fractals |
| M | 10 Sept | Maple I | Maple lab |
| T | 11 Sept | 2.4 | matrix products |
| W | 12 Sept | 3.1 | kernel and image |
| F | 14 Sept | 3.2 | subspaces |
| M | 17 Sept | 3.2-3.3 | independence and bases |
| T | 18 Sept | 3.3 | dimension |
| W | 19 Sept | 3.4 | coordinates |
| F | 21 Sept | review | chapters 1-3 |
| M | 24 Sept | 1-3 | exam 1 |
| T | 25 Sept | 4.1 | vector spaces |
| W | 26 Sept | 4.2 | linear transformations |
| F | 28 Sept | 4.3 | coordinates |
| M | 1 Oct | 4.3 | cont'd |
| T | 2 Oct | 5.1 | orthonormal bases |
| W | 3 Oct | 5.1 | cont'd |
| F | 5 Oct | none | fall break day |
| M | 8 Oct | 5.2 | Gram-Schmidt |
| T | 9 Oct | 5.2-5.3 | and orthogonal transformations |
| W | 10 Oct | 5.3 | cont'd |
| F | 12 Oct | 5.4 | least squares |
| M | 15 Oct | Maple II | Maple lab |
| T | 16 Oct | 5.5 | inner product spaces |
| W | 17 Oct | 5.5 | Fourier series |
| F | 19 Oct | 6.1 | intro to determinants |

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|---|---|---|---|
| M | 22 Oct | 6.2 | determinant properties |
| T | 23 Oct | 6.2 | cont'd |
| W | 24 Oct | 6.3 | geometric meaning |
| F | 25 Oct | 6.3 | cov in multiple integrals |
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| M | 29 Oct | review | 4-6 |
| T | 30 Oct | exam 2 | 4-6 |
| W | 31 Oct | 7.1 | dynamical systems |
| F | 2 Nov | 7.1-7.2 | and eigenvalues |
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| M | 5 Nov | 7.2-7.3 | eigenvectors |
| T | 6 Nov | 7.3 | cont'd |
| W | 7 Nov | 7.4 | diagonalization |
| F | 9 Nov | 7.4 | cont'd |
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| M | 12 Nov | 7.5 | complex numbers |
| T | 13 Nov | 7.5 | and eigenvectors |
| W | 14 Nov | extra | Jordan form |
| F | 16 Nov | extra | Jordan form |
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| M | 19 Nov | 7.6 | stability |
| T | 20 Nov | 8.1 | symmetric matrices |
| W | 21 Nov | 8.1 | cont'd |
| F | 23 Nov | none | Thanksgiving break |
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| M | 26 Nov | 8.2, Maple III | quadratic forms |
| T | 27 Nov | 8.2 | conics and quartics |
| W | 28 Nov | extra | second derivative test |
| F | 30 Nov | extra | cont'd |
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| M | 3 Dec | 8.3 | singular values |
| T | 4 Dec | 8.3 | cont'd |
| W | 5 Dec | review | review for final |
| F | 7 Dec | none | U. reading day |
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| Th | 13 Dec | FINAL EXAM | entire course 1:00-3:00 p.m. |