MATHEMATICS 290
LINEAR ALGEBRA

(Course number changed from Math 232 Spring 2006)

I. Introduction

A. Catalog Description

This course is a study of the basic concepts of linear algebra, and includes an emphasis on developing techniques for proving theorems. The students will explore systems of linear equations, matrices, Euclidean vector spaces, bases, dimension, linear transformations, determinants, eigenvalues, abstract vector spaces, change of basis, and matrix representations of linear transformations. Students will have the opportunity to use calculators or computer software to explore computationally intensive problems. *Prerequisite: Math 181.* Satisfies the Mathematical Reasoning core requirement. Satisfies the Writing in the Discipline requirement.

B. Objectives

This course serves two main purposes. First, linear algebra has application to many different disciplines - physics, chemistry, engineering, economics, and almost every area of mathematics. It also finds application in the social sciences. Thus, many of the students in this course will not be mathematics majors, but they will see how the results and techniques learned in this course might apply to their major.

Second, students who plan to take upper-division courses in mathematics will experience the theoretical development of a subject that is built up from a set of axioms rather than the more formula-oriented aspects of the three semesters of calculus. Thus, they will see careful proofs of a number of mathematical theorems and have many opportunities to develop and present their own proofs. Upon finishing this course, a student should have the mathematical maturity to move on to more rigorous courses. For this reason Math 290 is an explicit prerequisite for most upper-division mathematics courses.

This course satisfies the Mathematical Approaches category of the university's core curriculum by developing an appreciation of the power of Mathematics and formal methods to provide a way of understanding a problem unambiguously, describing its relation to other problems, and specifying clearly an approach to its solution. A student in this course will develop a variety of mathematical skills, an understanding of formal reasoning, and a facility with applications. Specifically, this course will develop the study of formal logic, at least to the extent that is required to understand mathematical proof.

C. Prerequisites

Math 181.

II. Required Topics

A. Matrices & Systems of Equations

1. Solutions to systems of linear Equations
2. Gauss and Gauss-Jordan elimination
3. Matrix representations of systems of equations
4. Matrix algebra

5. Nonsingular matrices
6. Inverses of matrices

B. Euclidean Vector Spaces

1. The vector space R^n
2. Subspaces
3. Linear independence
4. Spanning sets
5. Bases
6. Dimension
7. Orthogonality
8. Linear transformations

C. Determinants

1. Computations with cofactors
2. Effects of row operations
3. Cramer's rule

D. Eigenvalues

1. Characteristic equations
2. Eigenspaces
3. Similarity
4. Diagonalization

E. Abstract Vector Spaces

1. Subspaces
2. Linear independence
3. Spanning sets
4. Bases
5. Dimension
6. Linear transformations
7. Matrix representations of linear transformations
8. Change of basis

III. Optional Topics

A. Theory

1. Inner product spaces
2. Over-determined systems and data-fitting
3. Quadratic forms
4. Numerical techniques
5. QR factorization

B. Application Examples

1. Kirchoff's laws
2. Linear programming and simplex method
3. Algebraic graph theory
4. Markov chains
5. Fourier series

IV. Bibliography

J.B. Fraleigh, R.A. Beauregard, Linear Algebra, 3rd Edition, Addison-Wesley, 1995

S.I. Grossman, Elementary Linear Algebra, 4th Edition, Saunders, 1991

R.O. Hill, Elementary Linear Algebra, Academic Press, 1986

L.W. Johnson, R.D. Riess, J.T. Arnold, Introduction to Linear Algebra, 3rd Edition, Addison-Wesley, 1993

W.K. Nicholson, Linear Algebra with Applications, PWS Publishing, 1990

G. Strang, Linear Algebra and Its Applications, 3rd Edition, Harcourt Brace Jovanovich, 1988

G. Strang, Introduction to Linear Algebra, Wellesley-Cambridge Press, 1993

V. Requirements

Homework exercises, writing exercises, written examinations.