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Course Outline for MATH 7

ELEMENTARY LINEAR ALGEBRA

Effective: Fall 2011

I. CATALOG DESCRIPTION:
MATH 7 — ELEMENTARY LINEAR ALGEBRA — 3.50 units

An introduction to linear algebra including: techniques and theory needed to solve and classify systems of linear equations using Gaussian elimination and matrix algebra; properties of vectors in n-dimensions; generalized vector spaces, inner product spaces, basis, norms, orthogonality; eigenvalues, eigenspaces; and linear transformations. Selected applications of linear algebra, including the use of MATLAB™ to solve problems involving advanced numerical computation.

3.00 Units Lecture 0.50 Units Lab

Prerequisite
MATH 2 - Calculus II
with a minimum grade of C

Grading Methods:
Letter Grade

Discipline:

	MIN
Lecture Hours:	54.00
Lab Hours:	27.00
Total Hours:	81.00

II. NUMBER OF TIMES COURSE MAY BE TAKEN FOR CREDIT: 1

III. PREREQUISITE AND/OR ADVISORY SKILLS:

Before entering the course a student should be able to:

A. MATH2
   1. Sketch curves defined by parametric equations;
   2. Sketch curves defined by polar equations;
   3. Perform basic vector algebra in two-space and three-space and interpret the results geometrically;
   4. Find dot product and cross product of vectors.

IV. MEASURABLE OBJECTIVES:

Upon completion of this course, the student should be able to:

A. Solve systems of linear equations using any of the following methods: elimination, inverse or LU factorization;
B. Determine whether a linear system is consistent or inconsistent, and for consistent systems, characterize solutions as unique or infinitely many;
C. Apply the algebraic properties of vectors and matrices to simplify expressions and to write proofs;
D. Perform operations with vectors and matrices;
E. Compute the transpose, determinant, and inverse of matrices if defined for a given matrix;
F. Recognize and use the properties of vector spaces and inner products spaces;
G. Define subspace, inner product space, linear independence, basis, spanning set, and orthogonality;
H. Determine if a given set of vectors is a subspace of a vector space;
I. Define a linear transformation and represent it using matrix multiplication;
J. Recognize and use the properties of linear transformations;
K. Compute the characteristic polynomial, eigenvalues, eigenvectors and eigenspaces for a given matrix;
L. Construct orthogonal and orthonormal bases for a given basis;
M. Construct the orthogonal diagonalization of a symmetric matrix;
N. Use basic MATLAB™ command and functions to perform matrix operations;
O. Investigate and solve linear algebra applications using MATLAB™.

V. CONTENT:
A. Systems of linear equations
   1. Basic terminology and notation
   2. Classification of solution sets of a system of linear equations
      a. Consistent or inconsistent
      b. Unique solutions

        c. Infinite number of solutions and parameterization
    3. Gaussian and Gauss-Jordan elimination
    4. Row-echelon and reduced row-echelon form
    5. Back-substitution and forward-substitution
B. Matrix algebra
    1. Operations
    2. Properties
C. Inverse of a matrix
    1. Definition
    2. Methods for computing the inverse of a matrix
    3. Invertibility
    4. Using the inverse to solve Ax = b
    5. Relationship between singular and non-singular coefficient matrices and the solutions of a system of linear equations
D. Transpose of a matrix
E. Special matrices
    1. Diagonal
    2. Triangular
    3. Symmetric
F. Determinants
    1. Definition
    2. Methods of computing
        a. Cofactor expansion
        b. Elementary row operations
    3. Properties of the determinant function
G. Vectors in n-space
    1. Algebra of vectors
    2. Norm of a vector
    3. Dot product
    4. Angle between vectors
    5. Orthogonality of two vectors
    6. Scalar and vector and orthogonal projection
H. Generalized vector spaces
    1. Defintion
    2. Properties
    3. Vector addition and scalar multiplication
    4. Axioms
    5. Subspaces
    6. Linear independence and dependence, span
    7. Basis and dimension
I. Generalized inner product spaces
    1. Definition
    2. Axioms
    3. Norm
    4. Orthogonality of two vectors
J. Matrix-generated spaces
    1. Row space
    2. Column space
    3. Null space
    4. Rank
    5. Nullity
K. Orthogonal and orthonormal bases; Gram-Schmidt process
L. Change of basis
M. Linear transformations
    1. Definitions
    2. Properties
    3. Matrices of general linear transformations
    4. Geometry of linear transformations
    5. Inverse linear transformations
    6. Kernel and range
    7. One-to-one and onto transformations
    8. Isomorphism
N. Eigenvalue Problems
    1. Methods for finding eigenvalues and eigenvectors
    2. Characteristic equation
    3. Eigenspace
O. Diagonalization
P. Orthogonal diagonalization of a symmetric matrix
Q. Proofs
    1. Use of proof techniques as they pertain to the content of the course
    2. Evaluation of correctness of a proof
R. Applications include, but are not limited to: Markov Chains, least-squares analysis with MATLAB™, polynomial curve fitting, use of linear transformations to transform graphs
S. Laboratory instruction in the use of MATLAB™ to
    1. Define vectors and matrices
    2. Perform algebra with matrices
    3. Obtain reduced row-echelon form
    4. Solve systems of linear equations
    5. Find the inverse of a matrix
    6. Find a LU factorization
    7. Calculate determinants
    8. Solve characteristic equations
    9. Exponentiate a matrix
    10. Graph

VI. METHODS OF INSTRUCTION:

A. **Lecture** -
B. **Discussion** -
C. Collaborative learning
D. **Lab** - assignments

F. Web- or CD-Rom-based tutorials
G. Student presentations

VII. TYPICAL ASSIGNMENTS:

A. Homework
  1. Homework should be assigned from the text and should include a sufficient number and variety of problems to develop both skill and conceptual understanding. Problems should range in level of difficulty from introductory level to challenging. A typical assignment should take an average student 1 to 2 hours for each hour in class.

B. Collaborative learning
  1. Collaborative learning, done in small groups of 2-4 students, can be used to introduce new concepts, build skills, or teach problem solving. Students may be asked to present their results on the board.
  2. Example collaborative learning assignment: Give each group a description of a possible subspace and ask them to determine whether it is a subspace or not. Then have the group present their results to the class and either explain why it is not a subspace or prove that it is.

C. Laboratory assignments
  1. Laboratory assignments can be used to reinforce fundamental concepts and skills, to explore
  2. of the curves.

VIII. EVALUATION:

A. **Methods**
  1. Other:
     a. Examinations
     b. Comprehensive final examination
     c. Laboratory assignments
     d. Any of all of the following at the discretion of the instructor
        1. Homework
        2. Quizzes (announced or unannounced, in-class or take home)
        3. Collaborative group activities
        4. Projects

B. **Frequency**
  1. Recommend minimum of three exams plus the final
  2. Homework should be assigned for each section covered
  3. Recommend minimum of ten laboratory assignments over the semester
  4. Number of quizzes and collaborative activities are at the discretion of the instructor

IX. TYPICAL TEXTS:

1. Larson, Ron, Robert P. Hostetler, and Bruce H. Edwards *Elementary Linear Algebra.* 5th ed., Houghton Mifflin Company, 2004.
2. Anton Howard, and Chris Rorres *Elementary Linear Algebra with Applications.* 9th ed., John Wiley & Sons, Inc, 2005.
3. Poole, David *Linear Algebra: A Modern Introduction.* 2nd ed., Thomson-Brooks/Cole, 2006.

X. OTHER MATERIALS REQUIRED OF STUDENTS:

A. Graphing calculator.