CSU The California State University

Introduction to Linear Algebra
TCSU MATH 250

A. Description

This course provides a careful development of the techniques and theory needed to solve and classify systems of linear equations. Solution techniques include row operations, Gaussian elimination, and matrix algebra. Also covered is a thorough investigation of the properties of vectors in two and three dimensions, leading to the generalized notion of an abstract vector space. A complete treatment of vector space theory is presented including topics such as inner products, norms, orthogonality, eigenvalues, eigenspaces, and linear transformations. Selected applications of linear algebra are included.

B. Recommended Preparation

A year of college calculus. Prior or concurrent course work with vector calculus or vector-intensive physics would be helpful.

C. Prerequisites

Calculus II

D. Minimum Unit Requirement

3 semester units

E. Course Topics

1. Systems of linear equations: basic terminology and notation
2. Gaussian elimination: row operations, row-echelon form, reduced row-echelon form, Gaussian elimination algorithm, Gauss-Jordan elimination algorithm, back substitution
3. Matrix algebra: operations, properties
4. Inverse of matrix: definition, method of computing the inverse of a matrix, invertibility
5. Relationship between coefficient matrix invertibility and solutions to a system of linear equations
6. Transpose of matrix
7. Special matrices: diagonal, triangular, and symmetric
8. Determinants: definition, methods of computing
9. Properties of the determinant function
10. Vector algebra for Rn
11. Dot product, norm of a vector, angle between vectors, orthogonality of two vectors in Rn
12. Real vector space: definition, properties
13. Subspaces of a real vector space
14. Linear independence and dependence
15. Basis and dimension of a vector space

16. Matrix-generated spaces: row space, column space, null space, rank, nullity
17. Inner products on a real vector space
18. Angle and orthogonality in inner product spaces
19. Orthogonal and orthonormal bases: Gram-Schmidt process
20. Best approximation: least squares technique
21. Change of basis
22. Eigenvalues, eigenvectors, eigenspace
23. Diagonalization
24. Orthogonal diagonalization of a symmetric matrix
25. Linear Transformations: definitions, examples
26. Kernel and range
27. Inverse linear transformation
28. Matrices of general linear transformations
29. Isomorphism

F. Student Learning Outcomes

Upon successful completion of the course, students will be able to:

1. Solve systems of linear equations by reducing an augmented matrix to row-echelon or reduced row-echelon form;
2. Determine whether a linear system is consistent or inconsistent, and for consistent systems, characterize solutions as unique or infinitely many;
3. Simplify matrix expressions using properties of matrix algebra;
4. Compute the transpose, determinant, and inverse of matrices if defined for a given matrix;
5. Define vector space, subspace, linear independence, spanning set and basis;
6. Define an inner product;
7. Determine if a function that maps two vectors from a vector space to a scalar is an inner product on that vector space;
8. Construct orthogonal and orthonormal bases using the Gram-Schmidt Process for a given basis;
9. Construct the orthogonal diagonalization of a symmetric matrix;
10. Define matrix transformations, linear transformations, one-to-one, onto, kernel, range or image, rank, nullity and isomorphism;
11. Compute the characteristic polynomial, eigenvalues, eigenvectors and eigenspaces for both matrices and linear transformations;
12. Prove basic results in linear algebra using accepted proof-writing conventions; and
13. Evaluate linear algebra proofs for accuracy and completeness.

G. CAN Equivalent

CAN MATH 26 (Equivalency ends Fall 2009)