JIMMA University

College of Natural Sciences

Department of Mathematics

Course tittle: Linear Algebra II
Course code: Math 326
Credit hours:3 Contact hrs:3 Tutorial :2
Prerequisite: Math325
Course category: Compulsory

Aims

The course intends to develop further concepts in Linear Algebra providing a foundation for studies in a number of other areas of mathematics and related fields

Course description

This course covers the characteristic equation of matrix, orthogonality, matrix factorizations, canonical forms, direct sum decomposition of vector spaces, bilinear, quadratic and positive definite forms.

Course Objective

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

- ➢ Find eigenvalues and eigenvectors of a square matrix.
- ➢ Identify similar matrices
- ➢ Diogonilize a matrix when this is possible
- ➢ Difine inner product space
- ➢ Find and apply LU factorization of matrix
- ➢ Understand the Gram-Schmidt process
- ➢ Find an orthogonal basis for a subspace
- ➢ Find an orthogonal complement of subspace
- ➢ Recognize and invert orthogonal matrices
- ➢ Comprehend the three canonical forms of matrices

Course outline

Chapter 1: The characteristic equation of a matrix

- ✓ Eigenvalues and eigenvectors
- ✓ The characteristic polynomial
- ✓ Similarity of matrices and characteristic polynomial
- ✓ The spectral radius of a matrix
- ✓ Diagonalization
- ✓ Decomposable matrices
- ✓ Minimal polynomial and Cayley-Hamilton theorem

Chapter2: Orthogonality

- ✓ The inner product
- ✓ Inner product space
- ✓ Orthonormal sets
- ✓ The Gram-Schmidt orthogonalization process
- ✓ Cauchy-Schwartz and triangular inequalities
- ✓ The dual space
- ✓ Adjoint of linear operators
- ✓ Self-adjoint linear operators
- ✓ Isometry
- ✓ Normal operators and the spectral theorem

- ✓ Factorization of a matrix (LU, cholesky, QR)
- ✓ Singular value decomposition

Chapter 3: Canonical forms

- ✓ Elementary row and column operations on matrices
- ✓ Equivalence of matrices of polynomials
- ✓ Smith canonical forms and invariant factors
- ✓ Similarity of matrices and invariant factors
- ✓ The rational canonical forms
- ✓ Elementary divisors
- ✓ The normal and Jordan canonical forms

Chapter 4: Bilinear and quadratic forms

- ✓ Bilinear forms and matrices
- ✓ Alternating bilinear forms
- ✓ Symmetric bilinear forms and quadratic forms
- ✓ Real symmetric bilinear forms

Chapter 5: Direct sum decomposition of vectors spaces

- ✓ Definition of a direct sum of vector spaces
- ✓ Projection and invariant subspaces of a linear operator
- ✓ Primary decomposition theorem

Teaching-learning methods

Three contact hours of lectures and two hours of tutorials per week. Students do home assignments.

Assignments /quizzes/ 20%
Mid semester examination 30%
Final examination 50%

Teaching materials

Textbooks:

- ➢ **Serge Lang, Linear Algebra**
- ➢ **Schaum's Outline in Linear Algebra**

References:

- ➢ **S. Lipschitz, Theory and problems of Linear Algebra, second Ed., McGraw-Hill1991**
- ➢ **Larson /Edwards,Elementary Linear Algebra,D.C. Heath and company, Lexington,1988**
- ➢ **J.N. Sharma and et al, Linear Algebra, Krishna prakashan Media(p) Ltd.,2003**
- ➢ **Isaak and Manougian, Basic Concept of Linear Algebra, 1st ed., George J.McLead Limited,1976**
- ➢ **Otto Bretscher, Linear algebra with application, 3rd ed., Prentice Hall, 2005**
- ➢ **Howard Anton, Elementary linear algebra, 8th ed., John Wiley, 2000**
- ➢ **K. Hoffman and R. kunze, Linear Algebra, 2nd ed., prentice Hall INC., 1971**

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