MATH 304 – MATRIX ALGEBRA AND APPLICATIONS – SYLLABUS

Department of Mathematics
Millersville University

Description

An introduction to matrix algebra with emphasis on applications: systems of linear equations, matrix algebra, determinants, Euclidean and general vector spaces, inner product spaces, eigenvalues and eigenvectors, matrix transformations, numerical methods for matrices, selected applications such as Markov chains, strategy games, cryptography, bar codes, Hadamard matrices, error-correcting codes, graph theory, computer graphics and internet search engines. (4.0 credits)

Credit will not be granted for both MATH 304 and 322.

Prerequisites

C- or better in MATH 161/163H.

Course Objectives

Students will gain an understanding of the fundamental concepts and acquire the essential technical skills of matrix algebra including:

- solving systems of linear equations,
- using and interpreting the reduced row-echelon form and transpose of a matrix,
- finding inverse matrices,
- constructing matrix transformations and describing the properties,
- evaluating determinants and applying the properties of determinants,
- working with vectors and matrices in finite-dimensional Euclidean vector spaces,
- determination of orthogonality and projections,
- determination of linear dependence/independence,
- finding a basis for a finite-dimensional vector space,
- describing the fundamental matrix vector spaces,
- finding eigenvalues, eigenvectors, and determining eigenspaces for a matrix,
- determining diagonalizability and diagonalizing a matrix,
- calculating and using the inner product and inner product spaces,
- performing the Gram-Schmidt process and QR-decomposition.

Students will learn some significant applications of matrix algebra including:

- Network analysis and electrical circuits,
- Best approximations: least squares,
- Markov chains,

- Introduction to graph theory,
- Strategy games,
- Computer graphics,
- Cryptography,
- Internet search engines.

Students will gain an understanding of elementary numerical matrix algebra including:

- LU decomposition and solution of linear systems,
- the power method and Rayleigh quotients,
- the singular value decomposition (SVD) of matrices and some of its applications.

Assessment

Assessment of student achievement of the course objectives will vary from one instructor to another. Typical assessment will be made through work in class, homework, and examinations administered in a traditional face-to-face classroom environment, in an online environment, or in a hybrid of face-to-face and online assessments.

Use of Technology

Students are expected to use calculators such as the Texas Instruments TI-84, and may also find web-based computing resources such as DESMOS, Symbolab, and Wolfram|Alpha useful. Students may also find languages such as Python with the NumPy package useful for conducting numerical linear algebra calculations.

Topics

The following topics will be explored in this course. Other topics may be explored at the discretion of the instructor and with time permitting.

1. Systems of Linear Equations
    a. Solutions and Elementary Operations
    b. Gaussian elimination
    c. Homogeneous equations
    d. Applications to Network Flow
    e. Applications to Electrical Networks
2. Matrix Algebra
    a. Matrix Addition, Scalar Multiplication, and Transposition
    b. Matrix-Vector Multiplication
    c. Matrix Multiplication
    d. Matrix Inverses
    e. Elementary Matrices
    f. Linear Transformations

g. LU-Factorization
h. Applications to Markov Chains

3. Determinants and Diagonalization
    a. Cofactor Expansion
    b. Determinants and Matrix Inverses
    c. Diagonalization and Eigenvalues
    d. Applications to Cryptography
4. Vector Geometry
    a. Vectors and Lines
    b. Projections and Planes
    c. Cross Product
    d. Linear Operators on 3-dimensional Euclidean Space
    e. Applications to Computer Graphics
5. Finite-dimensional Euclidean Vector Spaces
    a. Subspaces and Spanning
    b. Independence and Dimension
    c. Orthogonality
    d. Rank of a Matrix
    e. Similarity and Diagonalization
    f. Applications to Best Approximation and Least Squares
6. Orthogonality
    a. Orthogonal Complements and Projections
    b. Orthogonal Diagonalization
    c. Positive Definite Matrices
    d. QR-Factorization
    e. Numerical Computation of Eigenvalues
    f. Singular Value Decomposition (SVD)
    g. Pseudoinverse of a Matrix
    h. Applications to Error Correcting Codes

Recently Used Textbooks

- *Linear Algebra with Applications*, W. Keith Nicholson, Lyryx Learning, Inc. (2020).