KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
COLLEGE OF SCIENCE
FACULTY OF PHYSICAL AND COMPUTATIONAL SCIENCES
DEPARTMENT OF MATHEMATICS
CSM 273: LINEAR AND NUMERICAL ALGEBRA

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Credits: Three (3)
Term: First Semester 2021/2022

Course Objective

This is an undergraduate course for computer science students. Linear algebra is the study of linear systems of equations, vector spaces, and linear transformations. Solving systems of linear equations is a basic tool of many mathematical procedures used for solving problems in science and engineering. In this class we will concentrate on the mathematical theory and methods of linear and numerical algebra. The student will become competent in solving linear equations, performing matrix algebra, calculating determinants, and finding eigenvalues and eigenvectors. Moreover, this course is to provide students with a good understanding of the concepts of vectors. The course is designed to improve students analytical and mathematical reasoning abilities.

Course Outline

1. Vectors in Two and Three Dimensional Spaces: Combining Vectors. Addition. Scalar Multiplication. Component form. Magnitude. Parallel. Orthogonality. Unit Vectors. Dot Product. Vector Projection.

2. Matrices: Definition. Matrix Operations. Algebraic Properties of Matrix Operations. Linear Transformation. Power of a Matrix. Nonsingular Matrices. Tridiagonal Matrices. Quadratic forms. Symmetric Matrices. Orthogonal and Orthogonal Matrices. Complex Matrices.

3. Systems of Linear Equations: Solving Square Linear Systems. Gaussian Elimination. The Gauss-Jordan method Inverse Approach. Homogeneous Systems.

4. Vector Spaces: Subspaces of R^n. Linear Independence. Basis of a Subspace. The Rank of a Matrix.

5. Determinants: Developing the Determinant of a 2×2 and a 3×3 Matrix. Some Properties of Determinant.

6. Eigenvalues and Eigenvectors: Definitions and Examples. Selected Properties of Eigenvalues and Eigenvectors. Diagonalization. Orthogonal Matrices.

7. Vector and Matrix Norms: Vector Norms. Matrix Norms. Submultiplicative Matrix Norms. Computing the Matrix 2-Norm. Properties of the Matrix 2-Norm.

8. Conditioning of Problems and Stability of Algorithms: Computation Errors. Algorithm Stability. Conditioning of a Problem. Perturbation Analysis for Solving a Linear System.

9. Decomposition Methods: LU Decomposition with Gaussian Elimination. Using LU to Solve Equations. LU Decomposition with the Doolittle's Decomposition. LU Decomposition with Crout's Decomposition. The Cholesky Decomposition. Tridiagonal Systems. Gaussian Elimination with Partial Pivoting. QR Decomposition

10. Iterative Methods for Solving System of Equations: Jacobi Method. The Gauss-Seidel Iterative Method.

Assessment

There will be assignments, a mid-semester examination, and an end of semester examination. Assignments and mid semester form 30% of students total scores while end semester examination form 70%.

Resources

1. Numerical Linear Algebra with Applications Using Matlab, William Ford, 2015, Elsevier Inc.

2. Introduction to Linear Algebra, Lee W. Johnson, R. Dean Riess, Jimmy T. Arnold, 2002, Fifth Edition, Pearson Education.

3. Numerical Linear Algebra An Introduction, Holger Wendland, 2018, Cambridge University Press.

4. Linear Algebra; A Modern Introduction, David Poole, 2015, Cengage Learning.

5. Numerical Linear Algebra and Matrix Factorizations, Tom Lyche, 2020, Springer Nature Switzerland.