SC223 - Linear Algebra
Autumn 2023

1. Credit Structure: 3-1-0-4
2. Instructors: Rahul Muthu, Aditya Tatu
3. Course Objectives: Vectors is an essential idea to understand numerous natural phenomenon. Its applications starts right from mechanics and electrostatics and magnetostatics. These applications use equations involving vectors. Such ideas are abstracted to study solutions of a system of linear equations in several variables. A general framework abstracting general properties of vectors is called the vector space. Once abstracted these ideas unify several areas of physics, engineering and mathematics. This is essentially due to linear response approximation in most applications. Vector spaces helps in understanding ideas in coding theory and cryptography for ICT students.
4. Contents:
    - Linear Equations: System of Linear Equations, Elementary Row Operations, RREF, Invertible Matrices.
    - Vector Spaces: Basic definitions and properties, Subspace, Linear Independence, Bases and Dimension , Co-ordinates, Direct sum of subspaces.
    - Linear Transformations: Definition , Matrix representation of linear transformations, Invertible transformations, Change of Basis, Fundamental Subspaces, Definition of Rank and Nullity and the Rank-Nullity theorem, Dual spaces.
    - Inner product spaces. Orthogonality, Gram –Schmidt orthogonalization, Orthogonal (Fourier) expansions, Orthogonal Projections, Rotations and reflections in real vector spaces.
    - Eigenvalues and Eigenvectors: Definition of Eigen values and Eigen vectors, The Characteristic Polynomial, Diagonalization and conditions , algebraic and geometric multiplicities, Diagonalization of real symmetric matrices, Solving differential equations by diagonalization, Exponential of a matrix.
    - Complex vector spaces: The complex inner product, definition of Adjoint Hermitian and Unitary matrices, Normal matrices, Spectral theorem and Singular value decomposition
5. References:
    - Linear Algebra, Kenneth Hoffman, Ray Kunze.
    - Linear Algebra and its applications, David C. Lay.
    - Linear Algebra, Jin Ho Kwak, Sungpyo Hong.
    - Linear Algebra done right, Sheldon Axler.
6. Grading Policy: In-sem 1 - 30%, In-sem 2 - 30%, End Semester Examination - 40%.
7. Course Outcomes: After completion of the course, students should be able to:
    - Solve systems of linear equations and understand the nature of the solutions [P01 , P02, P012].
    - Demonstrate matrix representation of linear operators and understand the concepts through linear operators and matrices [P01, P02].
    - Perform calculations with vectors, eigenvalues and eigenvectors in n dimensions [P02, P012].