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MTH 402	Linear Algebra -I	4 Credits (48 hours)

Course Objectives

1. **Understand the fundamental concepts of vector spaces and linear transformations**: Grasp the principles of vector spaces, linear combinations, bases, dimension, linear transformations, null spaces, ranges, and matrix representations.
2. **Explore elementary matrices and determinants**: Learn about elementary matrix operations, matrix rank, inverses, and the properties and applications of determinants.
3. **Examine diagonalization and related matrix properties**: Study eigenvalues, eigenvectors, diagonalizability, The jordan form, Computation of invariant factors, and the Cayley-Hamilton theorem.
4. **Explore inner product spaces and associated linear operators**: Understand the Gram-Schmidt process, various linear operators and derive the spectral theorems.

Course Outcomes

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

1. Understand and utilize vector space principles, linear transformations, matrix representations, null spaces, and ranges in solving mathematical problems.
2. Conduct elementary matrix operations, determine matrix rank and inverses, and calculate determinants of various orders with an understanding of their properties.
3. Find eigenvalues and eigenvectors, assess the diagonalizability of matrices, and apply related concepts such as the Cayley-Hamilton theorem.
4. Work with inner products, norms, the Gram-Schmidt orthogonalization process, orthonormal complements, and adjoint linear operators.
5. Understand and use normal and self-adjoint operators, unitary and orthogonal operators, orthogonal projections, the spectral theorem, singular value decomposition, pseudo-inverse, and the geometry of orthogonal operators in mathematical contexts.

Contents

Unit I (12 Hours)

Vector spaces: Recapitulation of Vector spaces, Linear combinations and system of linear equations, linear dependence and linear independence, Bases and dimension, maximal linearly independent subsets.

Linear transformations: Linear transformations, null spaces, and ranges, The matrix representation of a linear transformation, Composition of linear transformations and matrix multiplication, Invertibility and Isomorphisms, The change of coordinate matrix, Dual spaces.

Unit II (12 Hours)

Elementary matrices: Elementary matrix operations and elementary matrices, The rank of a matrix and matrix inverses, System of linear equations - theoretical and computational aspects.
Determinants: Determinants of order 2, Determinants of order *n*, Properties of determinants, A characterization of the determinant.

Unit III (12 Hours)

Diagonalization: Eigenvalues and eigenvectors, Diagonalizability, Invariant subspaces and Cyley-Hamilton theorem.
Cyclic subspaces and annihilators, Cyclic decomposition and rational form, The jordan form, Computation of invariant factors.

Unit IV (12 Hours)

Inner product spaces: Recapitulation of inner products and norms, The Gram-Schmidt orthogonalization process and Orthonormal complements.
The adjoint of a linear operator, Normal and self adjoint linear operators, Unitary and orthogonal operators and their matrices, Orthogonal projections and spectral theorem, Bilinear and Quadratic forms, The geometry of orthogonal operators.

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MTH 403	Real Analysis-I	4 Credits (48 hours)

Course Objectives

1. **Understand properties of number systems**: Learn about real and complex number systems, ordered sets, fields, and Euclidean spaces.
2. **Learn basic topology**: Explore metric spaces, open and closed sets, compact sets, and connected sets.
3. **Study numerical sequences and series**: Investigate convergent sequences, series, root and ratio tests, and power series.
4. **Explore continuity and differentiation**: Examine limits, continuous functions, derivatives, mean value theorems, L'Hospital's rule, and Taylor's theorems.

Course Outcomes

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

1. Utilize properties of real and complex numbers, ordered sets, fields, and Euclidean spaces to solve mathematical problems.
2. Define metric spaces, identify open and closed sets, compact sets, perfect sets, and connected sets, and apply the Heine-Borel theorem.