# Linear algebra Cover All Topic

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## 1 Vectors and Vectors Spaces:

**1.1 Definition of vectors in Euclidean space.**

**1.2 Vector addition, scalar multiplication and their properties.**

**1.3 Linear combinations and span of vectors.**

**1.4 Basis, dimension and subspace of vector spaces.**

## 2 Matrices and Matrix Operations:

**2.1 Matrix representation, notation and basic operations(addition, subtraction, multiplication.)**

**2.2 Properties of matrices: transpose, symmetric, skew-symmetric, diagonal, identity matrices.**

**2.3 Inverse of a matrix, determinant and its properties**

**2.4 Eigenvalues, eigenvectors and eigendecomposition.**

## 3 Systems of Linear Equations:

**3.1 Solving systems of linear equations using matrices and methods like Gaussian elimination.**

**3.2 Matrix representation of linear systems.**

**3.3 Row echelon form, reduce row echelon form and applications**

## 4 Linear Transformations:

**4.1 Definition of linear transformations and their properties.**

**4.2 Kernel and image of linear transformations.**

**4.3 Matrix representation of linear transformations.**

## 5 Orthogonality and Inner Product spaces:

**5.1 Orthogonal vectors, orthogonal complements, and orthogonality in vector spaces.**

**5.2 Inner product definition and properties**

**5.3 Orthogonal projections, Gram-Schmidt process, and orthonormal bases.**

## 6 Vectors Norms and Metrics:

**6.1 Vector norms(e.g.,Euclidean norm, Manhattan norm, maximum norm).**

**6.2 Metric spaces, distance metrics and their properties.**

## 7 Singular Value Decomposition(SVD):

**7.1 Decomposition of a matrix into singular values and their applications.**

**7.2 Low-rank approximations using SVD.**

## 8 Eigenvalue Decomposition and Spectral Theory:

**8.1 Spectral theorem and its significance.**

**8.2 Applications of eigenvalues and eigenvectors in various contexts.**

## 9 Determinants and Cofactor Expansion:

**9.1 Properties of determinants and their use in various calculations.**

**9.2 Cofactor expansion method for determinants.**

## 10 Linear Algebra Applications:

**10.1 Applications in computer graphics, signal processing, machine learning, physics and engineering.**

**10.2 Linear algebra's role in data analysis, optimization, and scientific computing.**