### ****Linear Algebra Syllabus****

#### ****1. Introduction and Fundamentals****

* **~~Vectors and Scalars~~**~~: Definitions, properties, and operations (addition, scalar multiplication)~~.
* **The Geometry of Vectors**: Visualization in two and three dimensions, ~~dot product~~, and cross product.
* **Systems of Linear Equations**: Representation in matrix form, consistency of systems.

#### ****~~2. Matrices and Matrix Operations~~****

* **Definition of Matrices**: ~~Types of matrices (square, diagonal, identity, zero, etc.).~~
* **Matrix Operations**: ~~Addition, multiplication, and properties of matrix arithmetic~~.
* **Transposition and Symmetry**: ~~Transpose of a matrix, symmetric and skew-symmetric matrices~~.
* **Special Matrices**: ~~Identity matrix, diagonal matrices, and block matrices~~.

#### ****3. Solving Systems of Linear Equations****

* **Row Echelon Form (REF) and Reduced Row Echelon Form (RREF)**
* **Gaussian and Gauss-Jordan Elimination**: Step-by-step procedures.
* **Matrix Inversion Method**: Solving systems using the inverse of a matrix.
* **Cramer's Rule**: Application to solve systems of linear equations using determinants.

#### ****4. Vector Spaces and Subspaces****

* **Definition of Vector Spaces**: Properties and examples (e.g., Rn\mathbb{R}^nRn).
* **Subspaces**: Criteria for a subset to be a subspace.
* **Span and Linear Independence**: Definitions, examples, and implications.
* **Basis and Dimension**: Finding a basis, understanding dimension, the concept of a null space.

#### ****5. Linear Transformations****

* **Definition and Examples**: Transformation of vectors, kernel and image.
* **Matrix Representation of Linear Transformations**: Connecting transformations to matrices.
* **Properties of Linear Transformations**: Composition and invertibility.

#### ****6. Determinants****

* **Definition and Properties**: Calculating determinants for 2×22 \times 22×2, 3×33 \times 33×3, and n×nn \times nn×n matrices.
* **Cofactor Expansion**: Methods for computing determinants.
* **Applications of Determinants**: Invertibility, Cramer's rule, and volume interpretation.

#### ****7. Eigenvalues and Eigenvectors****

* **Definition**: Finding eigenvalues and eigenvectors for matrices.
* **The Characteristic Equation**: Polynomial equations derived from a matrix.
* **Diagonalization**: Conditions for diagonalizability, and applications.
* **Applications**: Stability analysis, power of matrices, and Markov chains.

#### ****8. Orthogonality and Inner Product Spaces****

* **Dot Product and Norm**: Definitions and geometric interpretation.
* **Orthogonal and Orthonormal Sets**: Gram-Schmidt process.
* **Projections**: Orthogonal projections, least squares approximation.
* **Orthogonal Matrices**: Properties and applications.

#### ****9. Advanced Topics (Optional/Depending on Course Level)****

* **Singular Value Decomposition (SVD)**
* **Spectral Theorem**: Applications for symmetric matrices.
* **Quadratic Forms**: Classification and applications.
* **Linear Algebra in Applications**: Computer graphics, data science, machine learning.