Title: Calculative Foundation
Duration: 6 Hours
Type: Theory + Practical

🎯 Objective:

You are tasked with analyzing and transforming a dataset using **Linear Algebra concepts** to derive meaningful insights. The project integrates **vectors, matrices, decompositions, and dimensionality reduction techniques** to give students hands-on practice in mathematical foundations widely applied in **Data Science, AI/ML, and Engineering**.

Problem Statement

A research institute has shared a dataset containing **students' performance scores across multiple subjects**. As a data analyst, your task is to apply **Linear Algebra techniques** to:

1. Represent and manipulate data using vectors and matrices.
2. Perform advanced operations (dot products, cross products, vector projections, norms).
3. Explore matrix decompositions (LU, SVD).
4. Apply dimensionality reduction techniques (PCA & LDA).
5. Interpret eigenvalues and eigenvectors to understand variance in the dataset.

You must complete the tasks **theoretically and practically (Python/Excel/Manual calculations)** within the allotted exam time.

Tasks

Part A: Vector & Matrix Fundamentals

1. Represent each student's subject scores as a **vector**.

2. Compute:
   - Norm-1 and Norm-2 of vectors.
   - Dot product and angle between two students' score vectors.
   - Cross product (for 3D selected subjects).
3. Find the **projection of one vector** onto another.

Part B: Matrix Operations

4. Form a **matrix** of students × subjects. Perform:
   - Matrix addition and multiplication.
   - Transpose and Inverse (if possible).
   - Determinant.

Part C: Linear Transformations & Geometry

5. Explain **line, plane, and hyperplane** with respect to your dataset dimensions.
6. Show how **dimensionality increases** from 2D → 3D → higher dimensions with hyperplanes.

Part D: Eigenvalues & Decomposition

7. Compute the **eigenvalues and eigenvectors** of the covariance matrix.
8. Perform **LU Decomposition** of the dataset matrix.
9. Perform **Singular Value Decomposition (SVD)** and explain its role in dimensionality reduction.

Part E: Dimensionality Reduction

10. Apply **Principal Component Analysis (PCA)** to reduce the dataset from multiple subjects to 2 dimensions.
11. Apply **Linear Discriminant Analysis (LDA)** to classify students into "Above Average" and "Below Average" categories.

📌 Expected Outcome

By completing this project, students will:

- Understand **vector and matrix manipulation** in real-world data.
- Apply **norms, dot/cross products, and projections** to performance data.
- Gain insights into **eigenvalues/eigenvectors** and their meaning.
- Implement **LU, SVD, PCA, and LDA** to simplify and interpret data.
- Build confidence in using **linear algebra foundations** in applied statistics and machine learning.

✅ Submission Guidelines

- Include practical implementation in Jupyter Notebook, or screenshots.
- Label all charts clearly and write short interpretations under each result.
- GitHub Repository:
  - Create a GitHub repository to host your project.
  - Upload your project files, including source code and documentation.
  - Add a document (PDF) explaining theory concepts with definitions.
  - Ensure that you provide a clear and descriptive README.md file.

Calculative Foundation
Mathematics & Advanced Statistics

BRING ON YOUR CODING ATTITUDE