Hometask 13

Apply **Principal Component Analysis (PCA)** and **Linear Discriminant Analysis (LDA)** for dimensionality reduction and visualization of fashion-related image data. Focus on understanding how each method transforms high-dimensional data and compare their effectiveness for class separation. Write a Python program to perform the following steps using the Fashion-MNIST dataset. Follow the instructions below:

1. **Load the Dataset:**
   - Use the **Fashion-MNIST dataset**, which contains grayscale images of 10 fashion categories (e.g., shirts, shoes, bags).
   - Each image is 28×28 pixels, flattened to a 784-dimensional vector.
2. **Preprocess the Data:**
   - Normalize pixel values to the range [0, 1].
   - Display at least one image from each category using a visualization library (e.g., `matplotlib`).
3. **Apply PCA for Dimensionality Reduction:**
   - Use `sklearn.decomposition.PCA` to reduce the feature space from 784 to **2 dimensions**.
   - Since PCA is unsupervised, do not pass class labels.
4. **Apply LDA for Dimensionality Reduction:**
   - Use `sklearn.discriminant_analysis.LinearDiscriminantAnalysis` to reduce the feature space to **2 dimensions**.
   - Provide the class labels to perform supervised transformation.
5. **Visualize PCA and LDA Results:**
   - Create two separate 2D scatter plots:

  - One for PCA-transformed data
  - One for LDA-transformed data
- Use different colors for different fashion classes in both plots.

6. **Analysis and Discussion:** Write a proper report summarizing the steps you have performed in this task. Your report should include visualizations (PCA LDA), explanations of dimensionality reduction and responses to the following points:

   - Which fashion categories appear well separated in PCA and LDA visualizations?
   - How does LDA's supervised transformation compare with PCA's unsupervised projection?
   - In what types of problems would you choose PCA over LDA and vice versa?