**Chapter 1 – Introduction**

**Objective:** Understand basic image types, display, and simple manipulations.

1. **Load and Display Images**
    - Load one grayscale image and one color image using MATLAB/Python.
    - Display both images side by side.
    - Observe and describe the difference between grayscale and color images in terms of channels, pixel intensity, and appearance.
2. **Negative of an Image**
    - Generate the negative of a grayscale image by subtracting each pixel intensity from the maximum (255 for 8-bit images).
    - Display the original and negative image side by side.
    - Explain how the negative image affects visual perception.
3. **Image Subsampling**
    - Downsample a grayscale image by factors of 2, 4, and 8.
    - Display the subsampled images alongside the original.
    - Discuss how image resolution and details change with subsampling.

**Chapter 2 – Digital Image Fundamentals**

**Objective:** Explore pixel operations, quantization, and bit-plane manipulation.

1. **Gray-Level Quantization**
    - Reduce a grayscale image to 2, 4, 8, 16, and 256 gray levels.
    - Display all versions.
    - Discuss how quantization affects image quality and visibility of details.
2. **Bit-Plane Slicing**
    - Extract all 8 bit-planes of an 8-bit grayscale image.
    - Display them in order from the most significant bit (MSB) to the least significant bit (LSB).
    - Explain which bit-planes contain most of the image information.

3. **Pixel Neighborhood Analysis**
    - Choose a pixel from a grayscale image.
    - List its 4-neighbors (top, bottom, left, right) and 8-neighbors (including diagonals).
    - Explain the concept of pixel neighborhoods and their importance in filtering and edge detection.

**Chapter 3 – Intensity Transformations & Spatial Filtering**

**Objective:** Enhance images using intensity transformations and spatial filters.

1. **Histogram and Histogram Equalization**
    - Plot the histogram of a grayscale image.
    - Apply histogram equalization to enhance contrast.
    - Display the original and equalized images and compare their histograms.
    - Discuss how histogram equalization improves image visibility.
2. **Contrast Stretching**
    - Perform linear contrast stretching on a low-contrast image.
    - Display the original and stretched images.
    - Explain the effect of stretching on pixel intensities and image appearance.
3. **Smoothing with Spatial Filters**
    - Apply an averaging filter (3×3 and 5×5 kernel) to smooth a grayscale image.
    - Display all smoothed images and compare the effect of kernel size on blurring.
    - Explain how smoothing affects noise and details.
4. **Sharpening with Laplacian Filter**
    - Apply a Laplacian filter to a grayscale image to enhance edges.
    - Display the original and sharpened images.
    - Describe how sharpening affects image features.

**Chapter 4 – Filtering in the Frequency Domain**

**Objective:** Learn to process images using frequency domain techniques.

1. **Fourier Transform and Spectrum Visualization**
    - Compute the 2D Fourier Transform of a grayscale image.
    - Display the magnitude spectrum using logarithmic scaling.
    - Explain the significance of low and high-frequency components in the image.
2. **Low-Pass Filtering in Frequency Domain**
    - Design and apply an Ideal Low-Pass Filter (ILPF) to blur an image.
    - Display the filtered image alongside the original.
    - Discuss how low-pass filtering removes high-frequency components.
3. **High-Pass Filtering in Frequency Domain**
    - Design and apply an Ideal High-Pass Filter (IHPF) to enhance edges.
    - Display the filtered image and compare it with the original.
    - Explain how high-pass filtering highlights fine details.
4. **Notch Filtering for Periodic Noise Removal**
    - Add synthetic periodic noise to a grayscale image (e.g., sinusoidal pattern).
    - Design and apply a notch filter in the frequency domain to remove the noise.
    - Display the noisy and filtered images.
    - Explain how notch filtering isolates and removes specific frequency components.