**Lab # 9: Filter Design using FDA Tool**

**Objective:**

1. To understand the Fourier Transform and its role in signal analysis.
2. To design and analyze digital filters using MATLAB’s Filter Design & Analysis (FDA) Tool.
3. To apply Fourier Transform concepts to visualize filter frequency responses.

**Description:**

The Filter Design and Analysis Tool (FDA Tool) is a powerful user interface for designing and analyzing filters. FDA Tool enables you to quickly design digital FIR or IIR filters by setting filter performance specifications, by importing filters from your MATLAB workspace, by directly specifying filter coefficients, or by adding, moving, or deleting poles and zeros. FDA Tool also provides tools for analyzing filters, such as magnitude and phase response plots and pole-zero plots.

To open the Filter Design and Analysis Tool (FDA Tool), type >> fdatool The Filter Design and Analysis Tool opens with the Design Filter panel displayed.

**LAB TASKS**

## **Task 1: Fourier Transform of Signals**

### **Steps:**

1. Generate the following signals in MATLAB:
   * A composite  **sinusoidal signal** with different frequencies e.g. 10, 50,100 ,300 and 400
   * A **square wave** (use square() function).
   * A **noisy signal** (add random noise to a sine wave).
2. Compute the **FFT (Fast Fourier Transform)** of each signal.
3. Plot:
   * The **time-domain** signal.
   * The **magnitude spectrum** (frequency domain).

## **Task 2: Filter Design using FDA Tool**

### **Steps:**

1. Open MATLAB’s **Filter Design & Analysis (FDA) Tool**:
   * Type fdatool or filterDesigner in the MATLAB command window.
2. Design the following filters and apply on signals generated in task 1:
   * **Low-pass filter** (Cutoff = 200 Hz, Sampling rate = 1000 Hz).
   * **High-pass filter** (Cutoff = 300 Hz).
   * **Band-pass filter** (Passband = 100–400 Hz).
   * **Band-stop filter (Stopband = 500- 800 Hz)**
3. Export the filter coefficients (b and a for IIR, b for FIR).
4. Apply the designed filters to a noisy signal and observe the output.

## **Task 3: Real-World Application (Audio Filtering)**

### **Steps:**

1. Record or load an **audio signal** (e.g., [y, fs] = audioread('sample.wav');).
2. Add **high-frequency noise** to the audio.
3. Design a **low-pass filter** (using FDA Tool) to remove noise.
4. Apply the filter and listen to the filtered audio (sound(y\_filtered, fs)).

## **Task 4: Audio Equalizer**

Design Equalizer in order to equalize audio. Use FDA tool to design filters of sliders and then use the resulting coefficients in filter() built-in function. Take fft of audio signal apply filter in frequency domain then again convert audio signal into time domain and play resultant audio. Design the GUI in MATLAB to control the gain of each band of frequencies as shown in the figure.

