FACULTY OF ENGINEERING, UNIVERSITY OF JAFFNA

DIGITAL SIGNAL PROCESSING – EC5011

LABORATORY SESSION 3

FILTER DESIGN USING MATLAB AND LABVIEW

PART 01 (FIR): Low Pass Filter Design

1. Determine the impulse response $h_d[n]$ of the lowpass filter whose frequency response is given by

$$H(\Theta) = \begin{cases} 1, & 0 \le |\Theta| \le \frac{\pi}{3} \\ 0, & \frac{\pi}{3} < |\Theta| < \pi \end{cases}$$

2. To obtain a finite impulse response from $h_d[n]$ a rectangular window of length N=9 is used. Compute the coefficients of the FIR filter with a linear phase characteristic and with this finite impulse response.

3. Determine the filter coefficients of normalized (DC gain) filter for (Q1). Plot the magnitude & phase response of the filter. Only for this question plot the frequency (both magnitude and phase response) without using freqz command but using fft (It should be plot in dB scale). You need to scale the x-axis in Hz. Take the number of fft samples as 4096 and sampling frequency as 8000Hz.

4. Design the above filter using 'fir1' MATLAB command with rectangular window (that is the MATLAB comand for windowing method). Plot the magnitude and phase response of this filter keeping the x-axis scaled to Hz.

5. Design the same filter using numerical optimization method using the MATLAB command firpm. Plot the magnitude and phase response of this filter keeping the x-axis scaled to Hz.

6. Compare the result you obtain from (3),(4) and (5) in terms of magnitude response.

PART 02 (IIR):

Implement the digital filter given in prelab PART2: IIR FILTER DESIGN

Suppose you have given the following filter parameters. You are asked to design IIR low-pass filter in MATLAB.

Sampling frequency 12000

Pass band 2000Hz

Pass band ripple 0.1dB

Stop band 3500Hz

Stop band attenuation 40dB

Design and plot the magnitude response (This time you can use the MATLAB commands, use the freqz command but need to plot y-axis as log magnitude and x-axis as in Hz scale) of four types (ellip, butter, cheby1, cheby2) of IIR filters. Compare and comment on the different shapes, ripples and transition bands.

PART 03:

1. Design the filter given in part 01, satisfying the pass band ripple & stop band attenuation requirement given in part 02. (use fdatool)

2. Compare this filter design with the filter that you designed in part 02 in terms of filter order and attenuation.

PART 04: Filtering a signal

Generate a composite sinusoidal signal with frequencies 600Hz, 1100Hz, 2300Hz and 5000Hz with a sampling frequency of 12000Hz. Filter the signal using one of the above filter (you can use the filter command; can you use convolution?) and plot the magnitude response of the input and output signals (always scale the x axis to Hz).

Comment on your results.

PART 05: High Pass Filter Design (FIR)

The ideal high pass filter is given as below.

$$H(\Theta) = \begin{cases} 0 & 0 \le |\Theta| \le \frac{3\pi}{4} \\ 1 & \frac{3\pi}{4} \le |\Theta| \le \pi \end{cases}$$

Design the above high pass filter using the window method (you can use ‘fir1’- matlab command) with rectangular window of N=9. Plot the magnitude and phase response of the filter keeping the x-axis scaled to Hz. (Sampling frequency = 8000Hz)