Independent University, Bangladesh

Department of Electrical and Electronic Engineering

BAETE Accredited

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ID: 2221855 **Sec: 02**

Course Title : Digital Signal Processing LAB
Course Code : EEE 321L / ETE 324L (New); ECR 305L (Old)
Instructor : Dr. Kh Shahriya Zaman
Experiment No. : **08**
Experiment Name : **Study on lowpass, highpass & bandpass FIR filters**

Objective:

To be able to design lowpass and highpass FIR filters using MATlab.

MATLAB function:

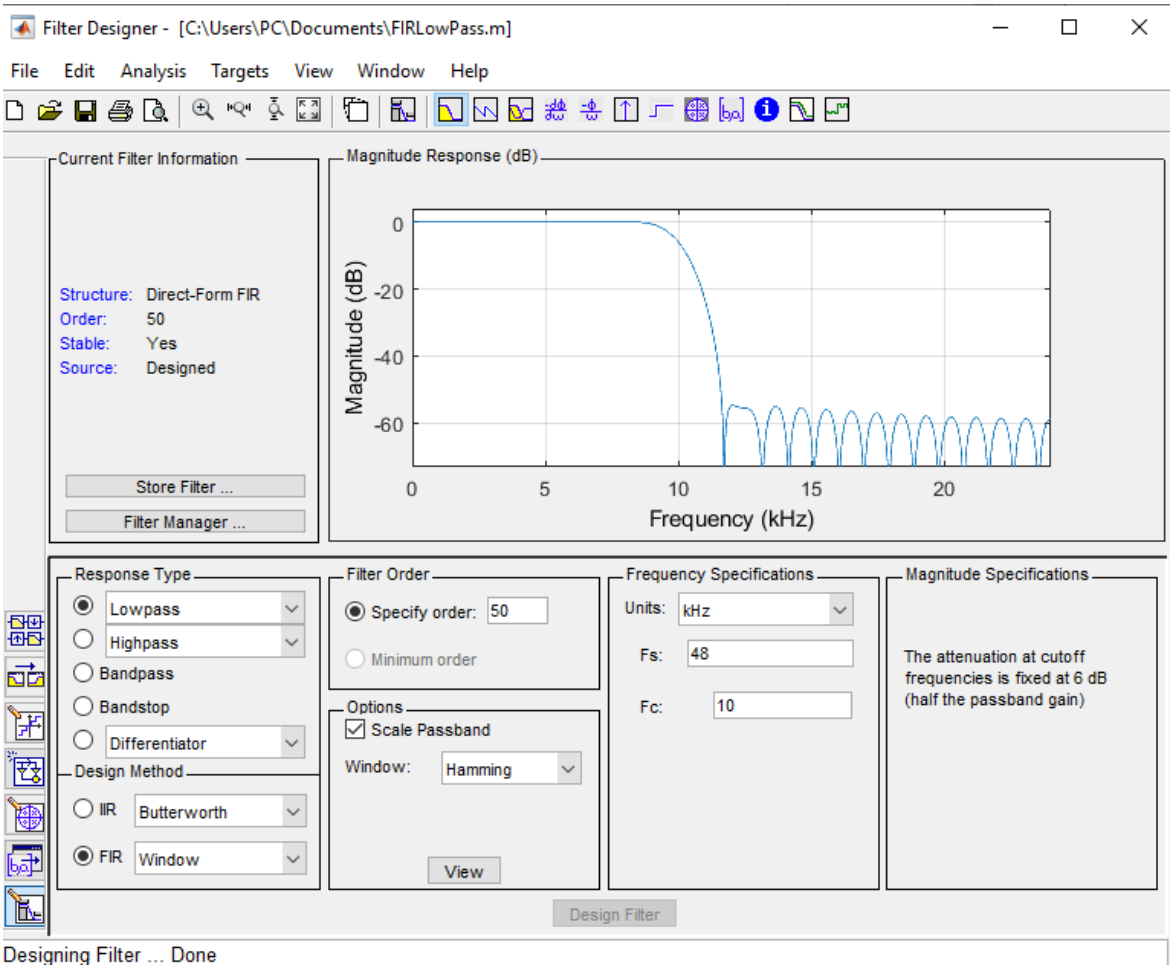
- filterDesigner

Lab work

1. Design a digital FIR **lowpass** filter of order 50 using **hamming** window with the following specifications:

Fs=48kHz, Fc=10kHz

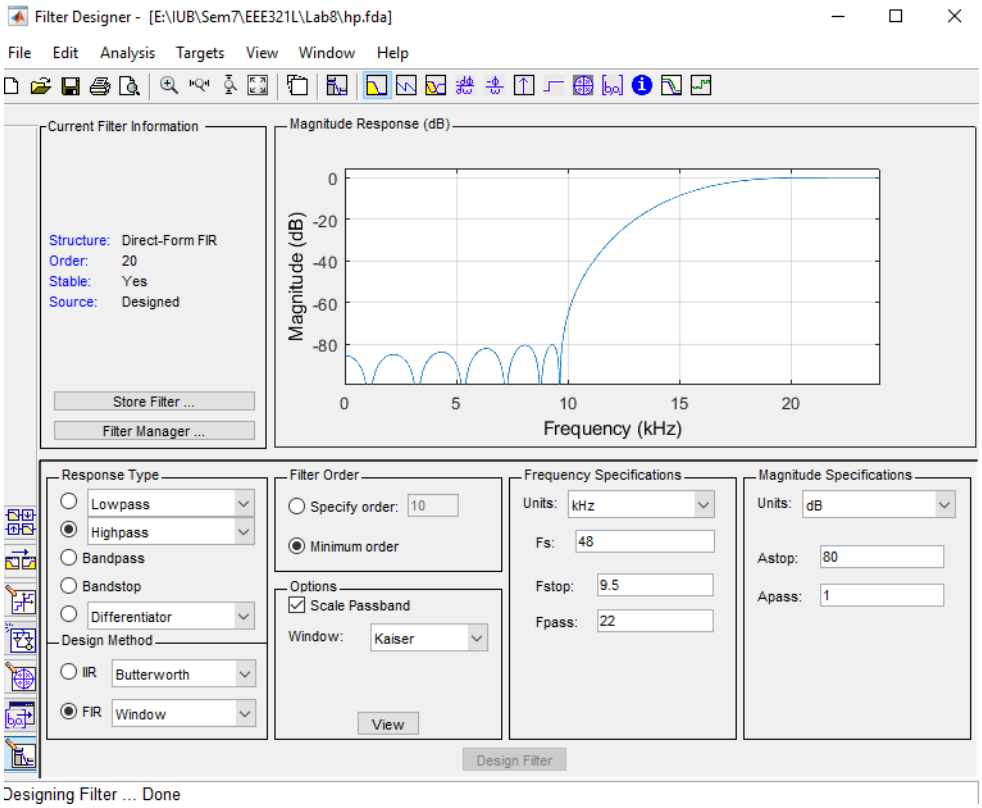
```
%Hemal Sharma
%ID:2221855
function Hd = FIRLowPass
%FIRLOWPASS Returns a discrete-time filter object.

% MATLAB Code
% Generated by MATLAB(R) 9.14 and DSP System Toolbox 9.16.
% Generated on: 26-Mar-2024 19:32:05

% FIR Window Lowpass filter designed using the FIR1 function.

% All frequency values are in kHz.
Fs = 48;  % Sampling Frequency

N    = 50;       % Order
Fc   = 10;       % Cutoff Frequency
flag = 'scale';  % Sampling Flag

% Create the window vector for the design algorithm.
win = hamming(N+1);

% Calculate the coefficients using the FIR1 function.
b  = fir1(N, Fc/(Fs/2), 'low', win, flag);
Hd = dfilt.dffir(b);

% [EOF]
```



2. Design a digital FIR high-pass filter of minimum order using a Kaiser window with the following specifications:

$$Fs=48kHz,\ F_{stop}=9.5kHz,\ F_{pass}=22kHz,\ A_{stop}=80dB,\ A_{pass}=1dB$$

```
%Hemal Sharma
%ID: 2221855
function Hd = FIRHighPass
%FIRHIGHPASS Returns a discrete-time filter object.

% MATLAB Code
% Generated by MATLAB(R) 9.14 and DSP System Toolbox 9.16.
% Generated on: 26-Mar-2024 19:34:27

% FIR Window Highpass filter designed using the FIR1 function.

% All frequency values are in kHz.
Fs = 48;  % Sampling Frequency

Fstop = 9.5;              % Stopband Frequency
Fpass = 22;               % Passband Frequency
Dstop = 0.0001;           % Stopband Attenuation
Dpass = 0.057501127785;   % Passband Ripple
flag  = 'scale';          % Sampling Flag

% Calculate the order from the parameters using KAISERORD.
[N,Wn,BETA,TYPE] = kaiserord([Fstop Fpass]/(Fs/2), [0 1], [Dpass Dstop]);

% Calculate the coefficients using the FIR1 function.
b  = fir1(N, Wn, TYPE, kaiser(N+1, BETA), flag);
Hd = dfilt.dffir(b);

% [EOF]
```

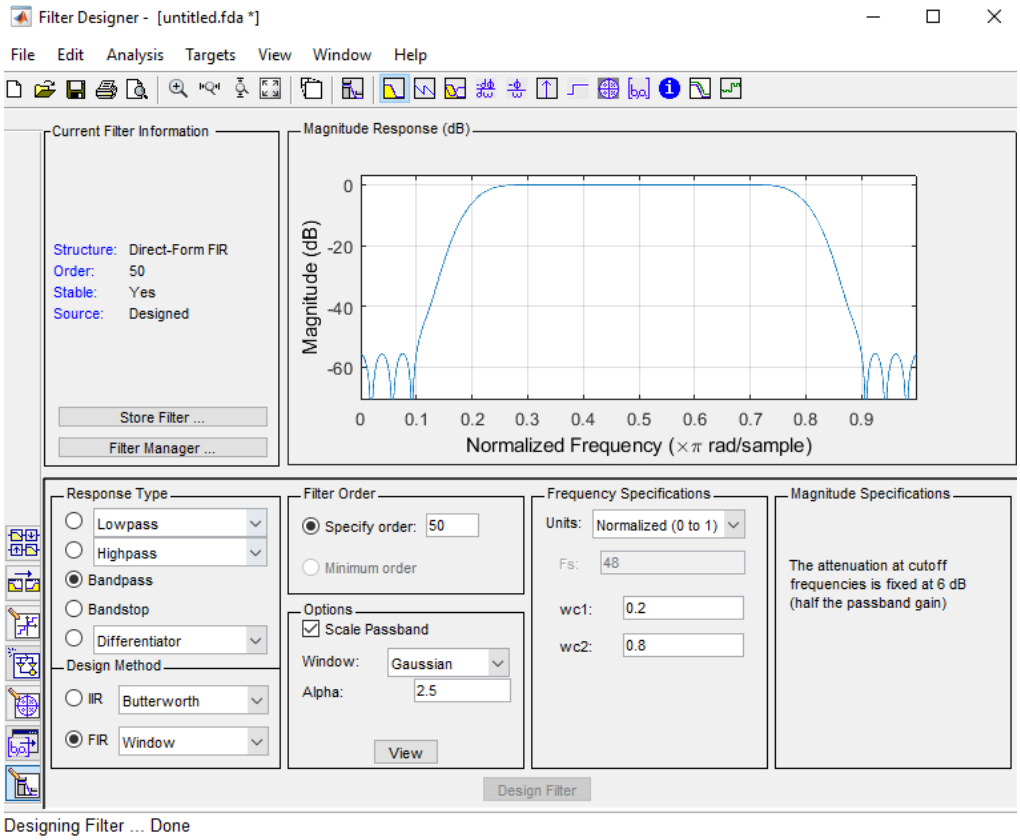


3. Design a digital FIR bandpass filter using a Gaussian window (50th order) with the following specifications:

$$\omega_{c1}=0.2N,\ \omega_{c2}=0.8N,\ \text{alpha}=2.5$$

where, N = Nyquist frequency (half of sampling frequency)

```
%Hemal Sharma
%ID: 2221855
function Hd = FIRBandPass
%FIRBANDPASS Returns a discrete-time filter object.

% MATLAB Code
% Generated by MATLAB(R) 9.14 and DSP System Toolbox 9.16.
% Generated on: 26-Mar-2024 20:17:52

% FIR Window Bandpass filter designed using the FIR1 function.

% All frequency values are normalized to 1.

N     = 50;       % Order
Fc1   = 0.2;      % First Cutoff Frequency
Fc2   = 0.8;      % Second Cutoff Frequency
flag  = 'scale';  % Sampling Flag
Alpha = 2.5;      % Window Parameter
% Create the window vector for the design algorithm.
win = gausswin(N+1, Alpha);

% Calculate the coefficients using the FIR1 function.
b  = fir1(N, [Fc1 Fc2], 'bandpass', win, flag);
Hd = dfilt.dffir(b);

% [EOF]
```

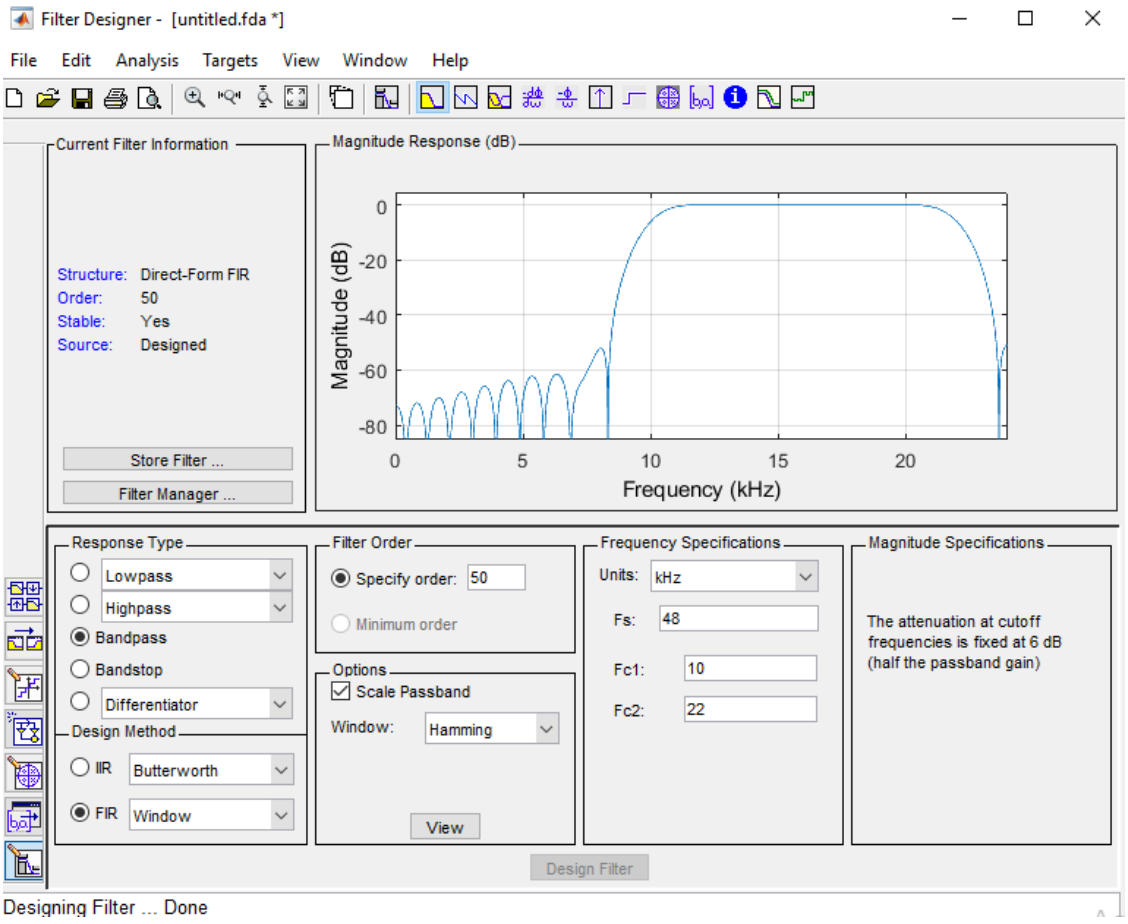


Lab-Assignment 8

1. Design a digital FIR bandpass filter of order 50 using hamming window with the following specifications:

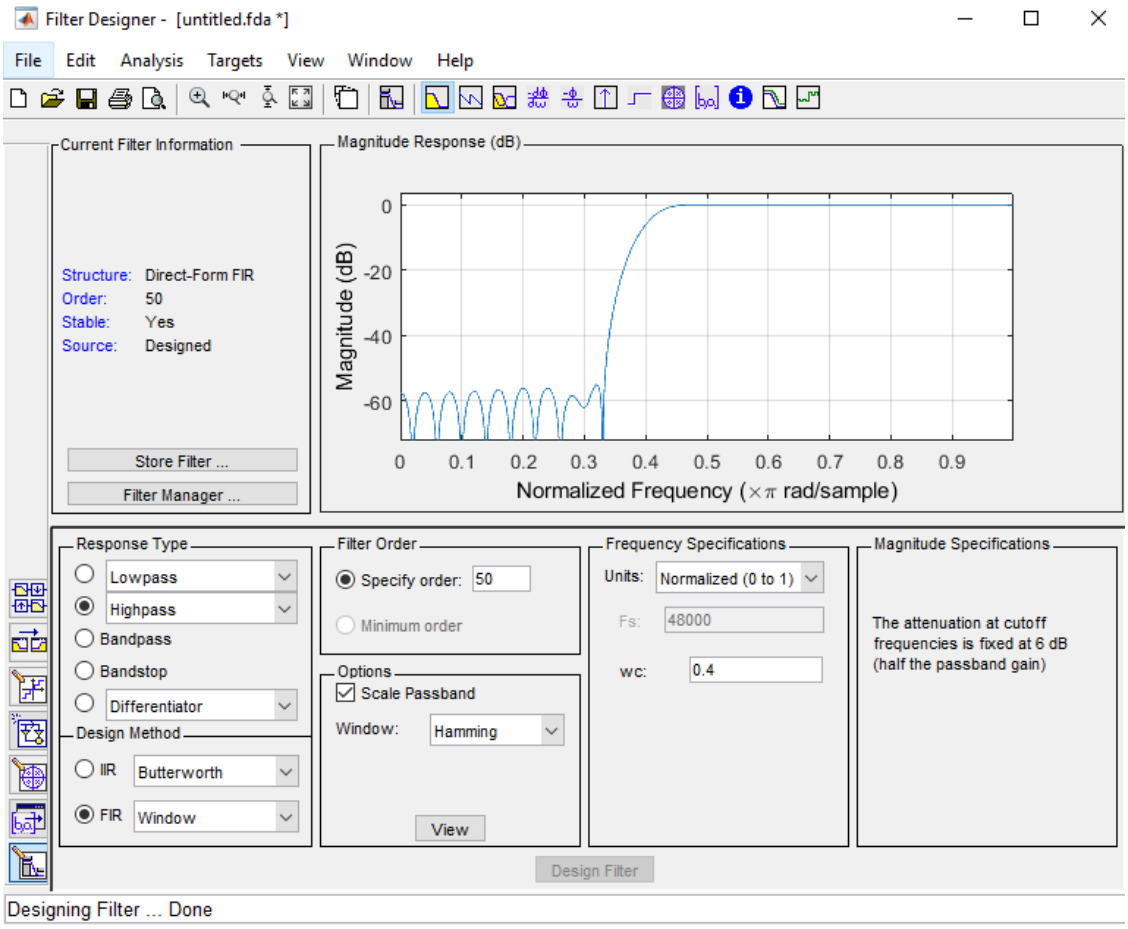
$$Fs=48kHz,\ F_{c1}=10kHz,\ F_{c2}=22kHz$$

```
%Hemal Sharma
%ID: 2221855
function Hd = FIRBandPass
%FIRBANDPASS Returns a discrete-time filter object.

% MATLAB Code
% Generated by MATLAB(R) 9.14 and DSP System Toolbox 9.16.
% Generated on: 26-Mar-2024 19:58:00

% FIR Window Bandpass filter designed using the FIR1 function.

% All frequency values are in kHz.
Fs = 48;  % Sampling Frequency

N    = 50;       % Order
Fc1  = 10;       % First Cutoff Frequency
Fc2  = 22;       % Second Cutoff Frequency
flag = 'scale';  % Sampling Flag
% Create the window vector for the design algorithm.
win = hamming(N+1);

% Calculate the coefficients using the FIR1 function.
b  = fir1(N, [Fc1 Fc2]/(Fs/2), 'bandpass', win, flag);
Hd = dfilt.dffir(b);

% [EOF]
```



2. Design an efficient digital FIR high-pass filter with the cutoff frequency at 40% of the Nyquist frequency.

```
%Hemal Sharma
%ID: 2221855
function Hd = HighPass
%HIGHPASS Returns a discrete-time filter object.

% MATLAB Code
% Generated by MATLAB(R) 9.14 and DSP System Toolbox 9.16.
% Generated on: 26-Mar-2024 20:43:39

% FIR Window Highpass filter designed using the FIR1 function.

% All frequency values are normalized to 1.

N    = 50;       % Order
Fc   = 0.4;      % Cutoff Frequency
flag = 'scale';  % Sampling Flag

% Create the window vector for the design algorithm.
win = hamming(N+1);

% Calculate the coefficients using the FIR1 function.
b  = fir1(N, Fc, 'high', win, flag);
Hd = dfilt.dffir(b);

% [EOF]
```


Filter Designer - [untitled.fda *]
File
Edit
Analysis
Targets
View
Window
Help
Current Filter Information
Structure: Direct-Form FIR
Order: 50
Stable: Yes
Source: Designed
Store Filter ...
Filter Manager ...
Magnitude Response (dB)
Magnitude (dB)
0
-20
-40
-60
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9
Normalized Frequency (×π rad/sample)
Response Type
Lowpass
Highpass
Bandpass
Bandstop
Differentiator
Design Method
IIR
Butterworth
FIR
Window
Filter Order
Specify order: 50
Minimum order
Options
Scale Passband
Window: Hamming
View
Frequency Specifications
Units: Normalized (0 to 1)
Fs: 48000
wc: 0.4
Magnitude Specifications
The attenuation at cutoff frequencies is fixed at 6 dB (half the passband gain)
Design Filter
Designing Filter ... Done