Experiment 8: Linear Phase F. I. R. Filter Design using Windowing Method

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Experiment No.	8

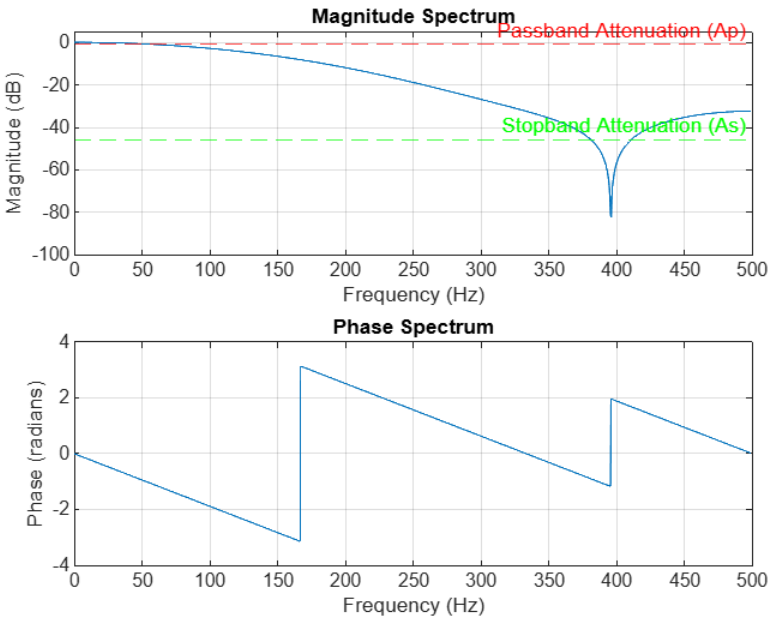
AIM:	Linear Phase FIR Filter design using window function.
OBJECTIVE:	To design the digital filter using windowing technique and study the spectrum of the filter.
INPUT SPECIFICATION:	**For LPF / HPF filter Design :** 1. Pass band Attenuation (Ap) 2. Stop band Attenuation (As > 40 dB) 3. Pass band Frequency (Fp) in Hz 4. Stop band Frequency (Fs) in Hz 5. Sampling Frequency in Hz 6. **For BPF / BSF filter Design :** 1. Pass band Attenuation (Ap) 2. Stop band Attenuation (As) 3. Pass band Frequency (Fp1, Fp2) in Hz 4. Stop band Frequency (Fs) in Hz 5. Sampling Frequency in Hz
PROBLEM DEFINITION:	1. Accept the input specifications for LPF, HPF, BPF and BSF. 2. Design the filter by selecting appropriate window function. 3. Plot magnitude spectrum and phase spectrum and verify the value of Ap and As in pass band and stop band from the magnitude spectrum. 4. Comment on Phase Spectrum.

LPF

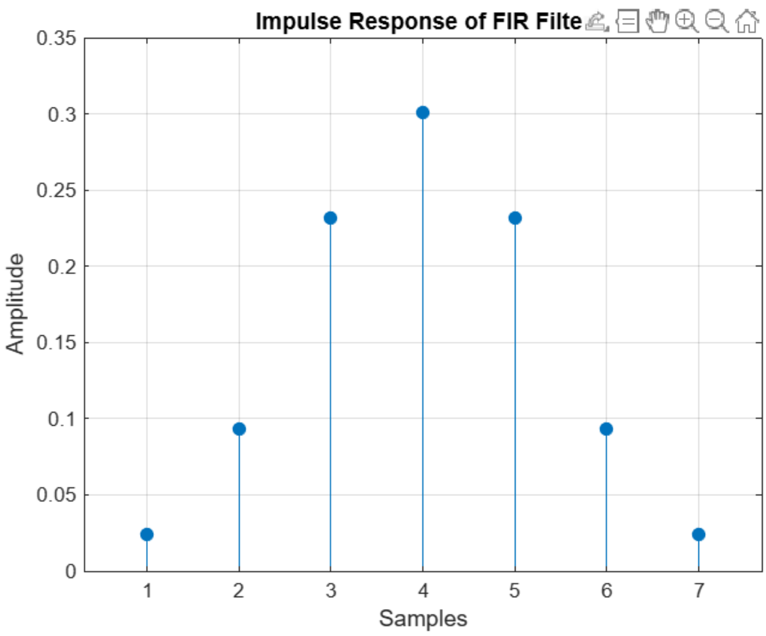
```
Step 1: Accept user input specifications
Enter filter type (LPF, HPF, BPF, BSF):
LPF
```

```
step 2: Select appropriate window function
Selected window: hamming

Step 3: Normalize frequencies
Wp = 2.0000e-04
Ws = 8.0000e-04


Step 4: Design the filter using the selected window
b = 1×7
     0.0241     0.0934     0.2319     0.3012     0.2319     0.0934     0.0241
```

Step 5: Frequency response



Step 7: Impulse response



Observe the phase spectrum for linearity. Linear phase indicates symmetry in the impulse

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response.
```

Higher order Filter

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Step 1: Accept user input specifications
Enter filter type (LPF, HPF, BPF, BSF):
LPF

step 2: Select appropriate window function
Selected window: hamming

Step 3: Normalize frequencies
Wp = 2.0000e-04
Ws = 8.0000e-04

Step 4: Design the filter using the selected window
b = 1×35
     0.0043     0.0048     0.0060     0.0081     0.0108     0.0143     0.0182 ⋯

Step 5: Frequency response
```
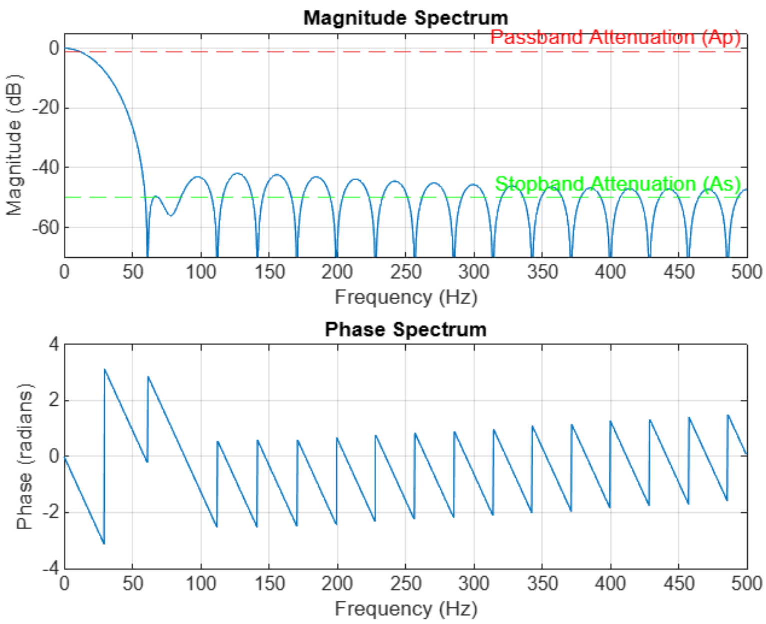
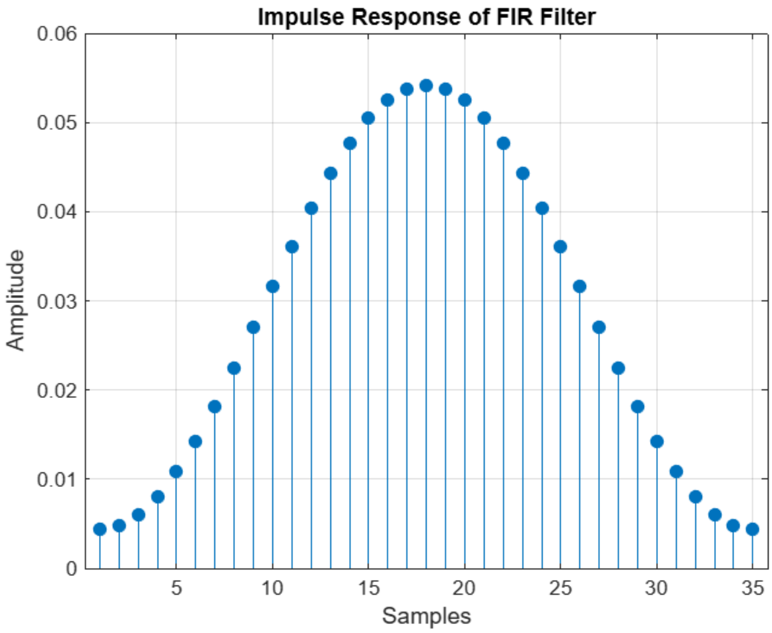




```
Step 7: Impulse response
```



`Observe the phase spectrum for linearity. Linear phase indicates symmetry in the impulse response.`

CONCLUSION:

1. The phase of the filter is linear in nature which is peculiarity of FIR filter , we verified it through matlab .
2. The value of Digital angular frequency must be -pi to pi and the unit is rad. The value of frequency must be between 0 to 0.5 which has no units.
3. Successfully designed and implemented Linear Phase FIR filters using the windowing method in MATLAB for LPF and higher-order filters.
4. Observed that the selection of an appropriate window function, such as Hamming, directly influences the filter's frequency response, providing a balance between main-lobe width and side-lobe attenuation.
5. Verified the passband attenuation (Ap) and stopband attenuation (As) from the magnitude spectrum, ensuring the designed filter meets input specifications.