

6. FIR FILTER (LP/HP) USING TRIANGULAR WINDOW TECHNIQUE

AIM:

To design a FIR filter using Triangular windowing technique and verify its frequency response.

APPARATUS:

PC with MATLAB

THEORY:

The window method for a causal linear-phase FIR filter is obtained by multiplying an ideal filter that has an infinite-duration impulse response (IIR) by a finite-duration window function:

$$h[n] = h_d[n]w[n]$$

where $h[n]$ is the practical FIR filter, $h_d[n]$ is the ideal IIR prototype filter, and $w[n]$ is the finite-duration window function. An important consequence of this operation is that the DTFTs of $h_d[n]$ and $w[n]$ undergo circular convolution in frequency

$$H(e^{j\omega}) = \frac{1}{2\pi} \oint_{2\pi} H_d(e^{j\theta}) W(e^{j(\omega-\theta)}) d\theta$$

Triangular (Bartlett) window

The Bartlett window is triangularly shaped

$$w[n] = \begin{cases} 1 - |(2n/M) - 1|, & 0 \leq n \leq M \\ 0, & \text{otherwise} \end{cases}$$

Because the Bartlett window can be thought of as having been obtained by convolving two rectangular windows of half the width. Its transform is easily obtained by squaring the transform of the rectangular windows:

$$W(e^{j\omega}) = \left(\frac{\sin\left(\frac{M\omega}{4}\right)}{\sin\left(\frac{\omega}{2}\right)} \right)^2 e^{-j\omega M/2}$$

The Bartlett window is having a wider mainlobe than the rectangular window, but more attenuated sidelobes

PROCEDURE:-

- Open MATLAB
- Open new M-file
- Type the program
- Save in current directory
- Compile and Run the program
- For the output see command window\ Figure window

PROGRAM:

DIGITAL SIGNAL PROCESSING LAB

```
% To design of FIR filters using triangular window techniques.
```

```
clc;
```

```
clear all;
```

```
close all;
```

```
% Low Pass Filter
```

```
n=20;
```

```
fp=200;
```

```
fq=300;
```

```
fs=1000;
```

```
fn=2*fp/fs;
```

```
window=triang(n+1);
```

```
b=fir1(n,fn>window);
```

```
[H W]=freqz(b,1,128);
```

```
subplot(2,1,1);
```

```
plot(W/pi,abs(H));
```

```
title('magnitude response of lpf');
```

```
ylabel('gain in db----->');
```

```
xlabel('normalized frequency----->');
```

```
subplot(2,1,2);
```

```
plot(W/pi,angle(H));
```

```
title('phase response of lpf');
```

```
ylabel('angle----->');
```

```
xlabel('normalized frequency----->');
```

```
% Highpass Filter
```

```
n=20;
```

```
fp=300;
```

```
fq=200;
```

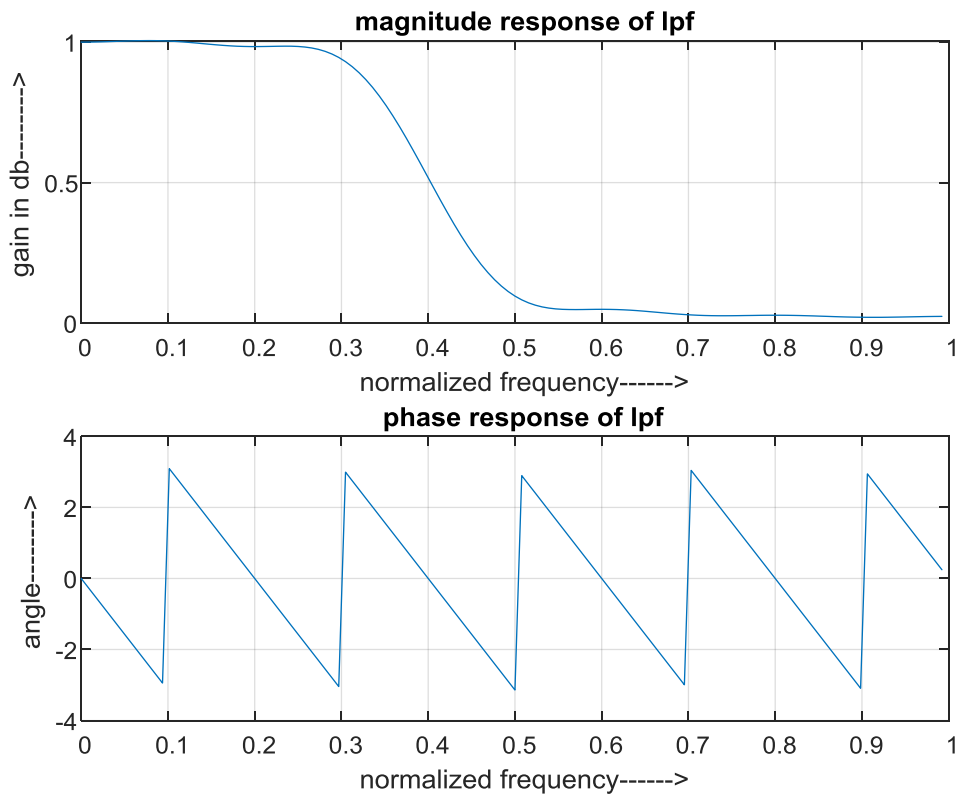
```
fs=1000;
```

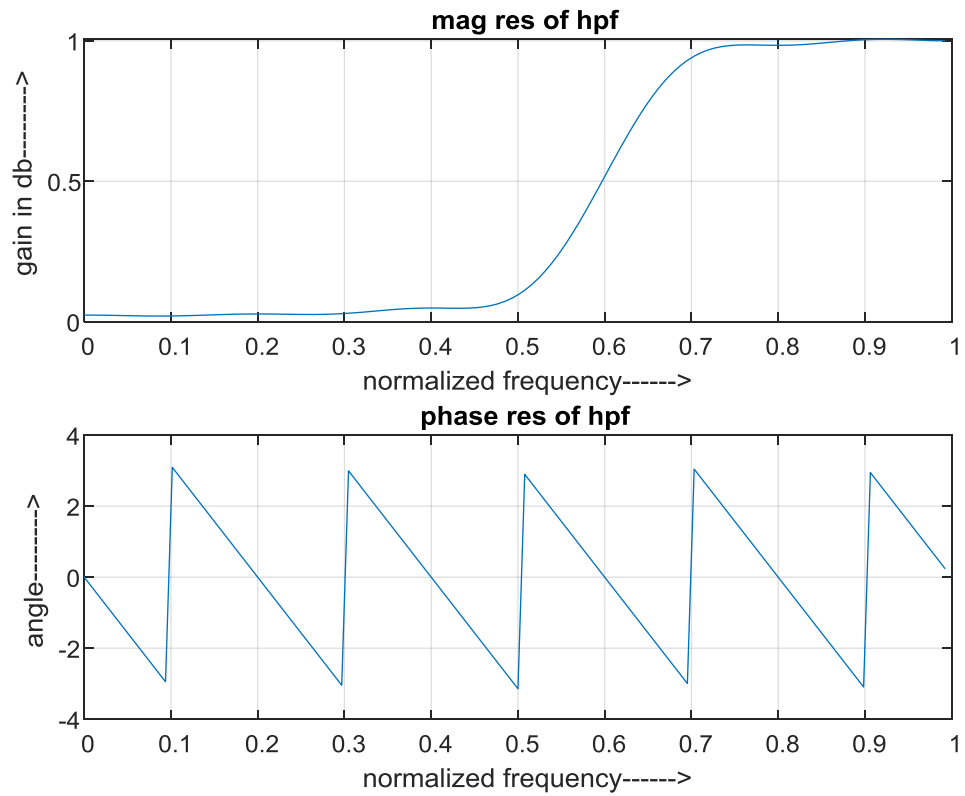
```
fn=2*fp/fs;
```

DIGITAL SIGNAL PROCESSING LAB

```
window=triang(n+1);  
b=fir1(n,fn,'high',window);  
[H W]=freqz(b,1,128);  
figure(2)  
subplot(2,1,1);  
plot(W/pi,abs(H));  
title('mag res of hpf');  
ylabel('gain in db----->');  
xlabel('normalized frequency----->');  
subplot(2,1,2);  
plot(W/pi,angle(H));  
title('phase res of hpf');  
ylabel('angle----->');  
xlabel('normalized frequency----->');
```

OUTPUT:





RESULT:

Thus the MATLAB program for FIR LP\HP using Triangular window Techniques was executed and its frequency response is also verified.