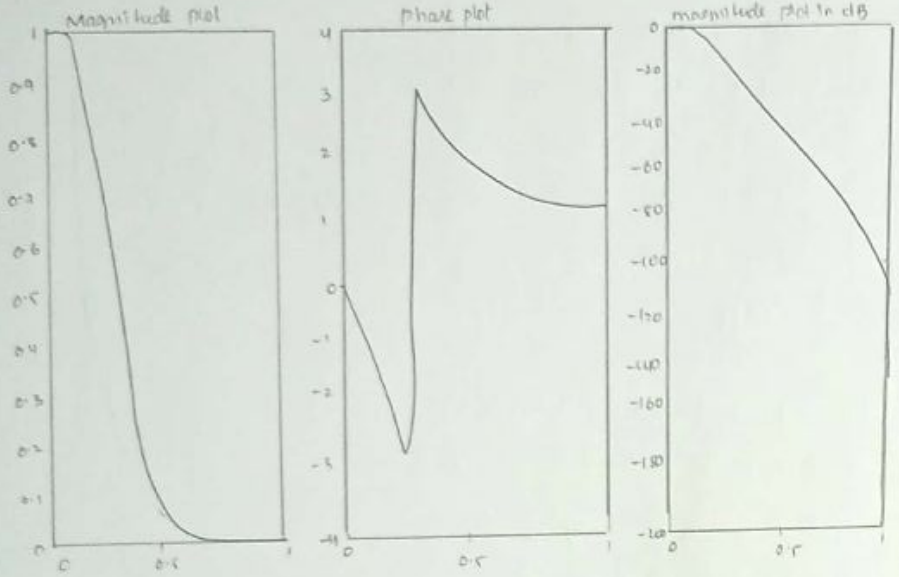
Experiment-5

IIR FILTERS

% Butterworth Low pass filter with $\alpha_p = 5dB$, $\alpha_s = 15dB$, $\Omega_p = 1000Hz$, $\Omega_s = 1500Hz$ $F = 10KHz$.

```
clc;
Clear all;
closeall;
rp = input ('enter the pass band in dB: ');
rs = input ('enter the stop band in dB;');
fp = input('enter passband cutoff frequency in hz: ');
fs = input ('enter stopband cutoff frequency in hz: ');
f = input ('enter the sampling frequency : ');
wp = 2*fp/f;
ws = 2*fs/f;
[N, wc] = buttord (wp, ws, rp, rs);
disp ('order of the filter = '); N
disp ('cutoff frequency' ); wc
[b, a] = butter (N, wc, 'low');
disp ('a'); a
disp ('b'); b
[H, om] = freqz (b, a);
subplot (1, 3, 1);
plot (om/pi, abs(H));
title ('magnitude plot');
subplot (1, 3, 2);
plot ((om/pi), angle(H));
```




```
title ('phase plot');
subplot (1,3,3);
plot (om/pi, 20*log10(abs(H)));
title ('magnitude plot in dB');
```

Result:

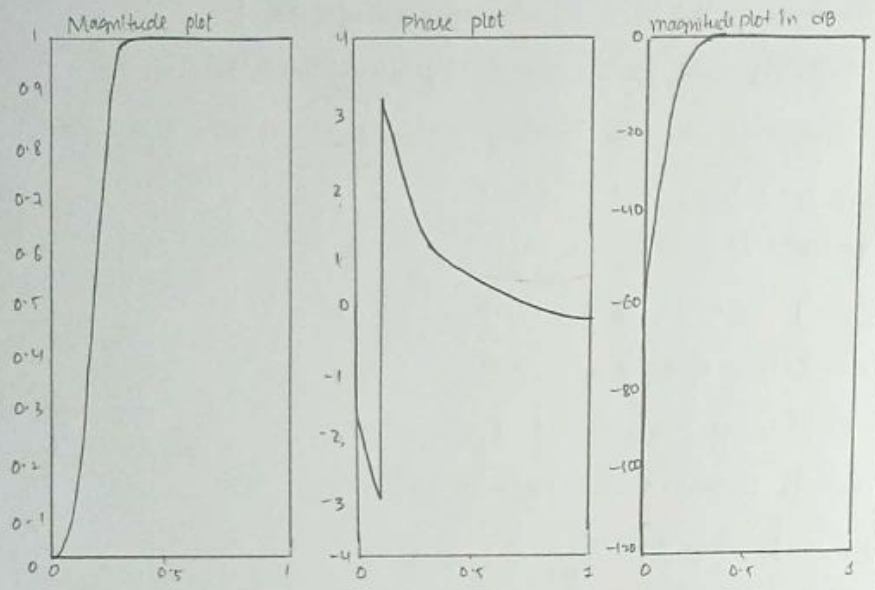
```
enter the pass band in dB: 5
enter the stop band in dB: 15
enter stopband cutoff frequency in hz: 1500
enter passband cut-off frequency in hz: 1000
enter the sampling frequency: 10000
Order of the filter=
N = 3
Cutoff frequency
wc = 0.1756

a =
  1.0000   -1.8904    1.3191   -0.3205

b =
  0.0135    0.0406    0.0406    0.0135
```

1. Butterworth high pass.

```
clc;
clear all;
close all;
rs = input('enter the stop band in dB:');
rp = input('enter the pass band in dB;');
fs = input('enter the stop band cutoff frequency in hz:');
fp = input('enter the pass band cutoff frequency in hz:');
f = input ('enter the sampling frequency:');
ws = 2*fs/f;
wp = 2*fp/f;
[N,wc] = buttord (ws, wp, rs, rp);
disp ['order of the filter = '); N
disp ['cutoff frequency'] ; wc
[b,a] = butter (N,wc, 'high');
[H,om] = freqz (b,a);
 disp ('a'); a
 disp ('b'); b
[H,om] = freqz (b,a))
subplot (1,3,1);
plot (om/pi, abs(H));
title ('magnitude plot');
```




```
subplot(1,3,2);
plot(com/pi, angle(H));
title('phase plot');
subplot(1,3,3);
plot(*com/pi, 20*log10(abs(H)))
title('magnitude plot in dB');
```

Result:

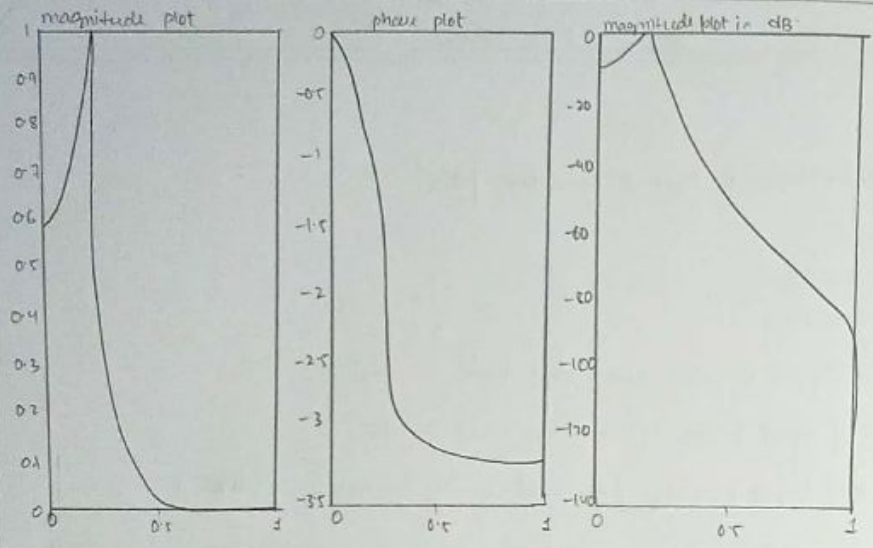
```
enter the stop band in dB: 5
enter the pass band in dB: 15
enter the stopband cutoff frequency in hz: 1000
enter the passband cutoff frequency in hz: 1500
enter the sampling frequency : 10,000
Order of the filter =
N = 3.
cutoff frequency
wc = 0.1786

a =
  1.0000   -1.8904   1.3191   -0.3205

b =
  0.5663   -1.6988   1.6988   -0.5663
```

```
% Chebyshev type-1 low pass filter

clc;
clearall;
closeall;
rp=input('enter the pass band in dB:');
rs=input('enter the stop band in dB:');
fp=input('enter pass band cutoff frequency in:');
fs=input('enter stop band cutoff frequency:');
f=input('enter the sampling frequency:');
wp=2*fp/f;
ws=2*fs/f;
[N,wc]=cheb1ord(wp,ws,rp,rs);
disp('order of the filter=');N
disp('cutoff frequency');wc
[b,a]=cheby1(N,rp,wc);
disp('a');a
disp('b');b
[H,om]=freqz(b,a);
subplot(1,3,1);
plot(om/pi),abs(H));
title('magnitude plot');
```



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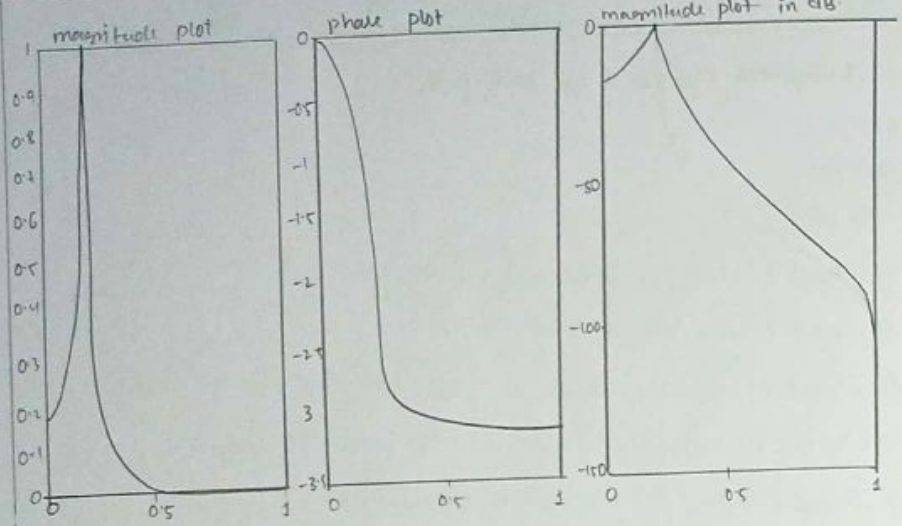
```
subplot(1,3,2);
plot(omlpi, angle(H));
title('phase plot');
subplot(1,3,3);
plot(omlpi, 20*log10(abs(H)));
title('magnitude plot in dB');
```

Result!

```
enter the pass band in dB: 5
enter the stop band attenuation in dB: 15
enter passband cutoff frequency: 1000
enter stop band cutoff frequency: 1500
enter the sampling frequency: 10000
order of the filter =
  N= 2
cutoff frequency
  wc = 0.2000

a =
   1.0000   -1.5442    0.7548

b =
   0.0296    0.0592    0.0290
```

Roll No. : Lecturer's Signature :

```
% chebyshev type-1 high pass filter
clc;
clear all;
close all;
rs = input ('enter the stopband in dB:');
rp = input ('enter the passband in dB:');
fs = input ('enter the stoppand cutoff frequency:');
fp = input ('enter the passband cutoff frequency:');
f = input ('enter the sampling frequency:');
ws = 2*fs/f;
wp = 2*fp/f;
[N, wc] = cheb1ord (ws, wp, rs, rp);
disp ('order of the filter =');N
disp ('cutoff frequency'); wc
[b,a] = cheby1 (N, rp, wc);
disp ('a'); a
disp ('b'); b
[H, om] = freqz (b,a);
subplot (1,3,1);
plot (om/pi), abs (H));
title ('magnitude plot');
subplot (1,3,2);
```

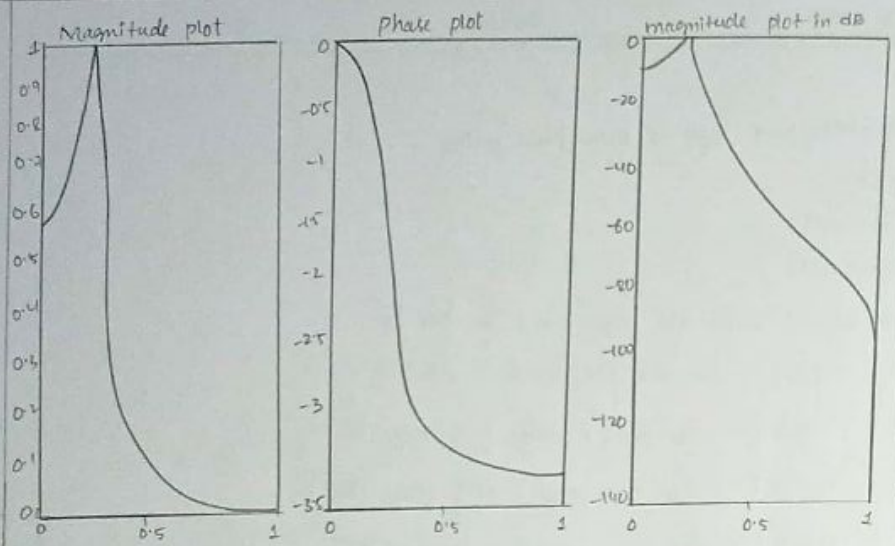



```
plot (com/pi), angle(H));
title ('phase plot');
subplot (1,3,3);
plot (com/pi , 20*log10 (abs(H)));
title ('magnitude plot in dB');
```

Result:

```
enter the stopband in dB: 5
enter the passband in dB: 15
enter Stopband cutoff frequency : 1000
enter Passband cutoff frequency: 1500
enter the sampling frequency: 10000
Order of the filter =
   N = 2
cutoff frequency
 wc = 0.2000

a =
   1.0000   -1.7285   0.9245

b =
   0.0087   0.0174   0.0087
```

```
% Chebyshev type -2 low pass filter
clc;
clear all;
close all;
rp = input ('enter the pass band in dB:');
rs = input ('enter the stop band in dB:');
fp = input ('enter pass cutoff frequency:');
fs = input ('enter stoppand cutoff frequency:');
f = input ('enter the sampling frequency:');
wp = 2*fp/f;
ws = 2*fs/f;
[N,wc] = cheb2ord (wp,ws,rp,rs);
disp ('order of the filter'); N
disp ('cutoff frequency'); wc
[b,a] = cheby2 (N,rp,wc);
disp ('a'); a
disp ('b'); b
[H,om] = freqz(b,a);
subplot (1,3,1);
plot (com/pi), abs(H));
title ('magnitude plot');
subplot ('1,3,2');
```




```
plot(com/pi), angle(H));
title ('phase plot');
subplot (1,3,3);
plot (om/pi, 20*log10 (abs(H)));
title ('magnitude plot in dB');
```

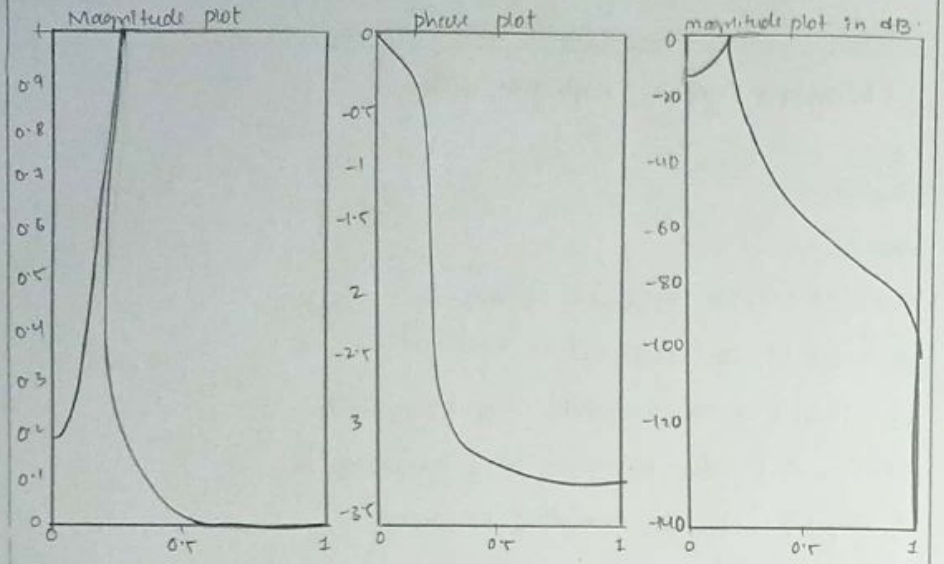
Result:

```
enter the pass band in dB: 5
enter the stop band attenuation in dB: 15
enter the pass band cutoff frequency : 1000
enter the stop band cutoff frequency : 1500
enter the sampling frequency: 10000
Order of the filter=
N = 2
cutoff frequency
Wc = 0.3000

a =
   1.0000   -1.2129   0.6646

b =
   0.0635   0.1270   0.0635
```

Expt. No. 5 Page No. 41 Date :

```
% Chebyshev type-2 high pass filter
clc;
clear all;
close all;
rs = input ('enter stopband in dB:');
rp = input ('enter passband in dB:');
fs = input ('enter stopband cutoff frequency');
fp = input ('enter passband cutoff frequency:');
f = input ('enter the sampling frequency');
ws = 2*fs/f;
wp = 2*fp/f;
[N,wc] = cheb2ord (ws,wp, rs,rp);
disp ('order of the filter'); N
disp ('cutoff frequency'); wc
[b,a] = cheby2 (N, rp, wc);
disp ('a'); a
disp ('b'); b
[H,om] = freqz (b,a);
subplot (1,3,1);
plot ([om/pi], abs(H));
title ('magnitude plot');
subplot (1,3,2);
```

Roll No. : Lecturer's Signature :



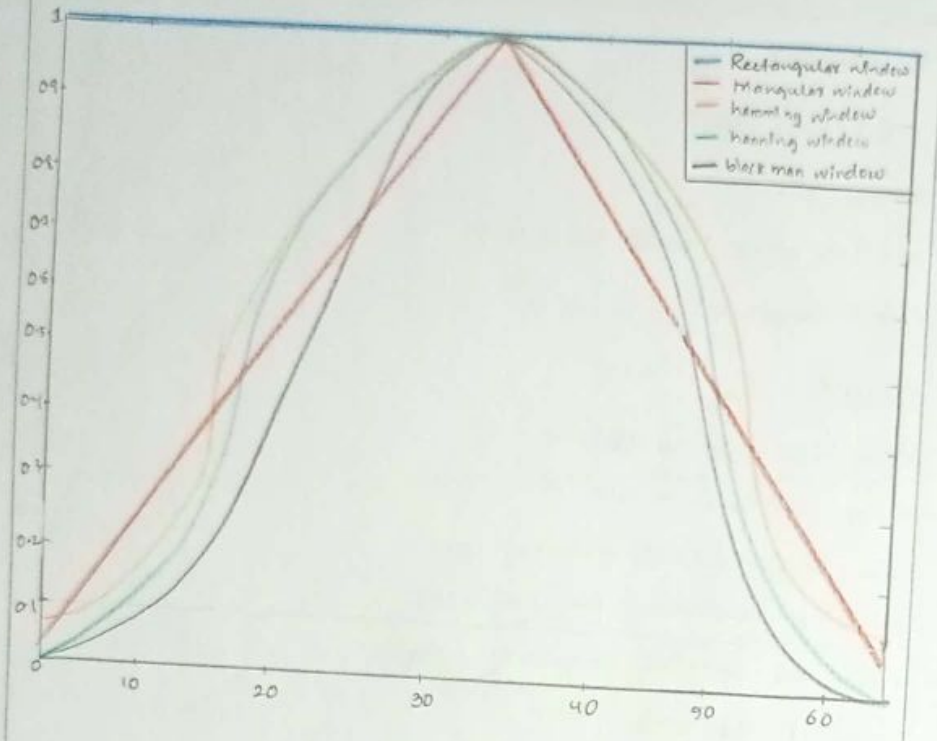
Expt. No. 5 Page No. 42 Date :

```
plot(com/pi), angle(H));
title('phase plot');
subplot(1,3,3);
plot(com/pi, 20*log10(abs(H)));
title('magnitude plot in dB');
```

Result:

```
enter stop band in dB: 5
enter pass band in dB: 15
enter stopband cutoff frequency: 1000
enter passband cutoff frequency: 1500
enter the sampling frequency: 10,000
Order of the filter=
N = 2
Cutoff frequency
  Wc =
    0.3000

a =
  1.0000   -1.4507   0.8916

b =
  0.0196   0.0392   0.0196.
```

Roll No. : Lecturer's Signature :

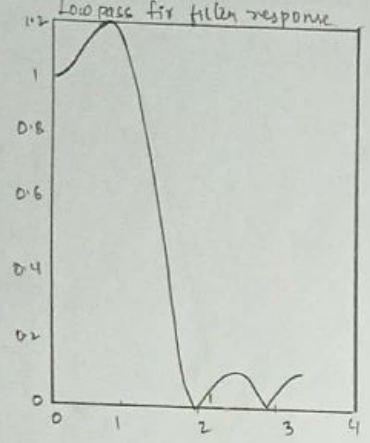


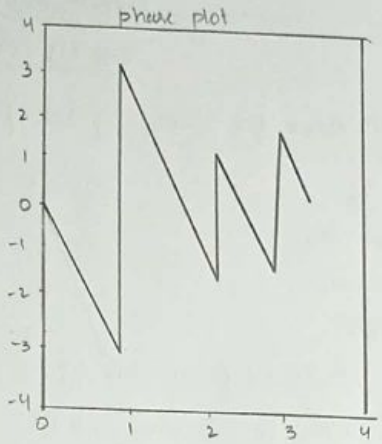
Experiment - 6.

FIR FILTERS

% Windows for designing FIR filters.

```
clc;
clear all;
close all;
n = 65;
w1 = window (@rectwin, n);
w2 = window (@triang, n);
w3 = window (@hamming, n);
w4 = window (@hann, n);
w5 = window (@blackman, n);
plot (1:n, [w1 w2 w3 w4 w5]);
axis ([1, n, 0, 1]);
legend ('Rectangular window', 'Triangular window', 'hamming window',
        'hanning window', 'blackman window');
```





Expt. No. 6 Page No. 44 Date :

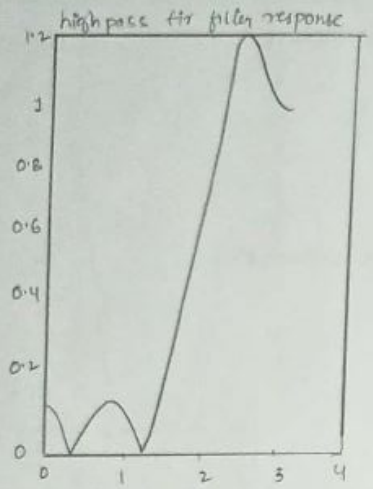
% FIR FILTERS USING RECTANGULAR WINDOWS.

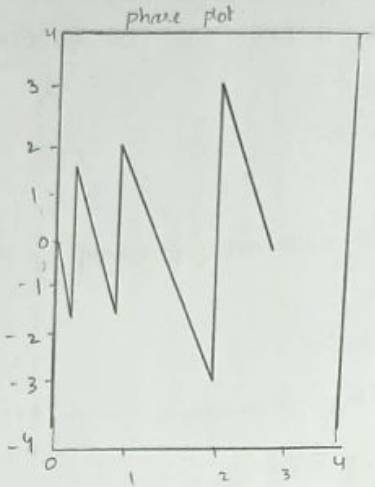
```
clc;
Clearall;
close all;

% LPF with cutoff frequency 0.5 pi and order=8.
N=8
wc=.5*pi;
b= fir1 (N, (wc/pi), rectwin (N+1));
disp ('b');b
w=0 : .001 : pi;
h= freqz (b,1,w))
subplot (1,2,1));
plot (w, abs (H));
title ('low pass FIR filter response');
subplot (1,2,2));
plot (w, angle (H));
title ('phase plot');
```

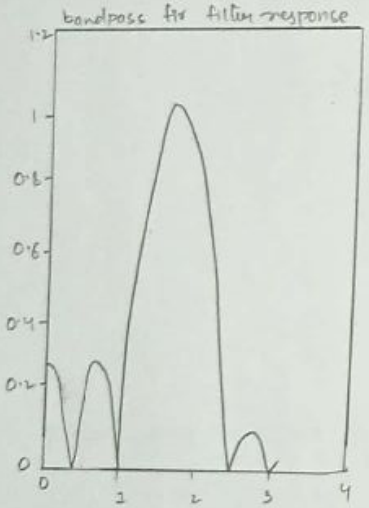
Result:

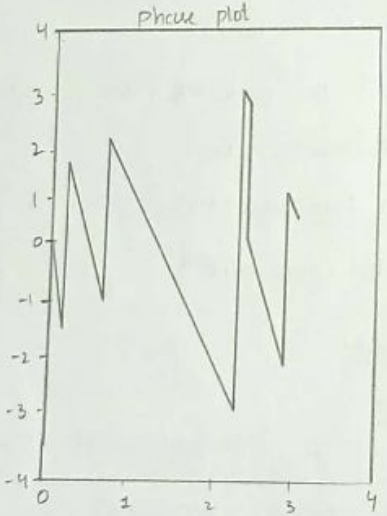
```
b =
  -0.0000   -0.1148    0.0000    0.3443    0.5409    0.3443    0.0000
  -0.1148   -0.0000
```

Roll No. : Lecturer's Signature :









Expt. No. 6 Page No. 45 Date :

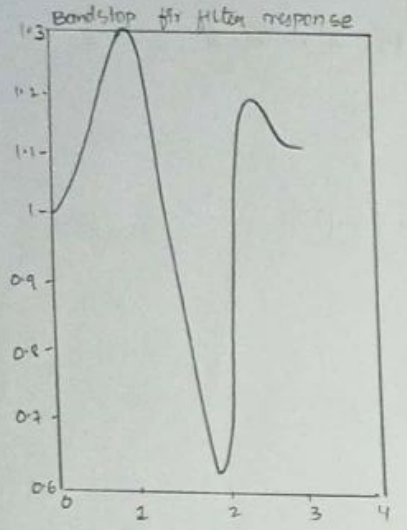
```
% HPF with cut-off frequency 0.5pi & order=2
N=2;
wc=0.5*pi ;
b= fir1 [N,(wc/pi),'high',rectwin (N+1));
disp ('b');b
w=0 : .001 : pi ;
H= freqz (b,1,w);
subplot (1,2,1);
plot (w, abs(H));
title ('high pass fir filter response');
subplot (1,2,2);
plot (w, angle(H));
title ('phase plot');
```

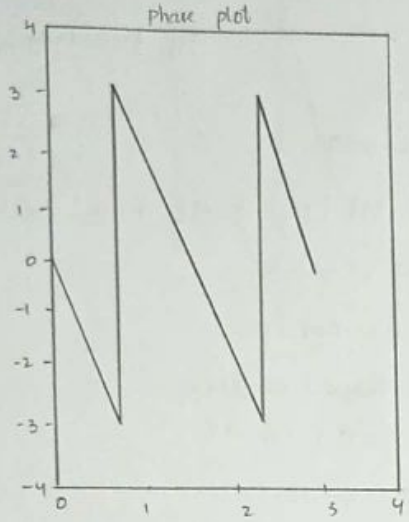
Result:

```
-0.0000  0.1148  -0.0000  -0.3443  0.5409
-0.3443  -0.0000  0.1148  -0.0000
```

```
% BPF with cutoff frequency 0.5pi & order=2.
N=2;
wc1=0.5*pi;
wc2=0.6*pi;
b= fir1 [N,[wc1/pi wc2/pi], 'bandpass', rectwin (N+1));
disp ('b');b
w=0 : .001 : pi;
H= freqz (b,1,w);
subplot (1,2,1);
plot (w, abs(H));
title ('bandpass fir filter response');
```

Roll No. : Lecturer's Signature :





Expt. No. 6 Page No. 46 Date :

```
subplot (1,2,2);
plot (w, angle (H));
title ('phase plot');
```

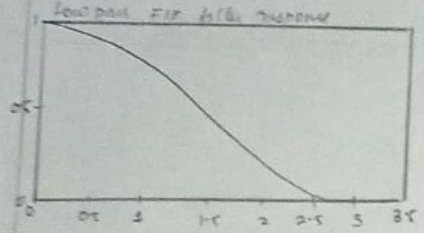
Result:

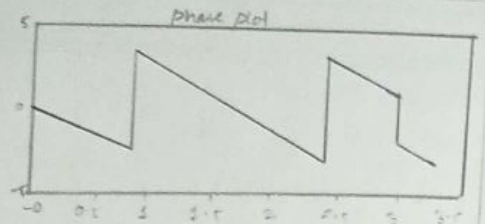
```
b =
  0.1701   0.0983  -0.2102  -0.0350   0.2247  -0.0350  -0.2102
  0.0983   0.1701.

% BRF with cutoff frequency 0.5pi & order = 8.
N=8
wc1 = 0.5*pi;
wc2 = 0.6*pi;
b = fir1 (N, [wc1/pi wc2/pi], 'stop', rectwin (N+1));
disp ('b'); b
w = 0 : .001 : pi;
H = freqz (b,1,w);
subplot (1,2,1);
plot (w, abs(H));
title ('bandstop fir filter response');
subplot (1,2,2);
plot (w, angle(H));
title ('phase plot');
```

Result:

b = -0.0861 -0.0497 0.0064 0.0177 1.0234 0.0177 0.0064 -0.0497 -0.0861

Roll No. : Lecturer's Signature :





Expt. No. ..... Page No. 47 Date : .....

% FIR filter using hamming window.

% LPF with cutoff frequency 0.5 pi and order = 8.

```
clc;
clear all;
close all;
N=8
wc = 0.5*pi;
b = fir1(N,(wc/pi), hamming(N+1));
disp('b'), b
w=0:.001:pi;
H= freqz(b,1,w)
subplot(1,2,1);
plot(w, abs(H));
title('low pass FIR filter response');
subplot(1,2,2);
plot(w, angle(H));
title('phase plot');
```

Result:

b = -0.0000 -0.0227 0.0000 0.2940 0.4974 0.2740

0.0000 -0.0227 -0.0000

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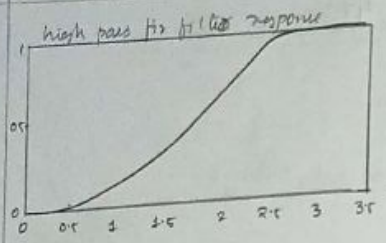
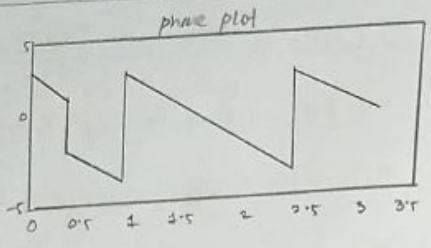




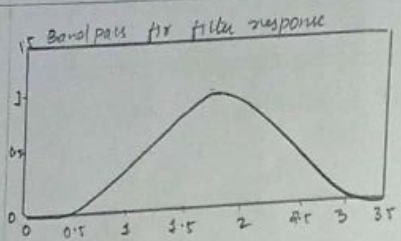
% HPF with cut-off frequency 0.5 pi & order = 8

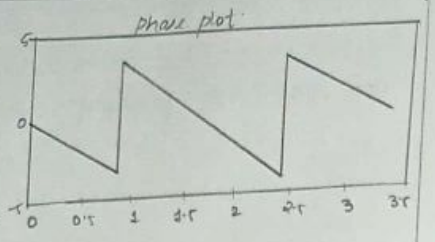
```
clc;
clear all;
close all;
N=8;
wc = 0.5*pi;
b= fir1 (N, (wc/pi), 'high', hamming(N+1));
disp ('b'), b
w= 0: .001 : pi;
H= freqz (b,1,w);
subplot (1,2,1);
plot (w, abs(H));
title ('high pass filter fir response');
subplot (1,2,2);
plot (w, angle (H));
title ('phase plot');
```

Result:

b = -0.0000 0.0227 -0.0000 -0.2740 0.4974 -0.2740

-0.0000 -0.0227 -0.0000





Expt. No. ..... Page No. 49 Date : .....

% BPF with cutoff frequency 0.5 pi & order = 8.

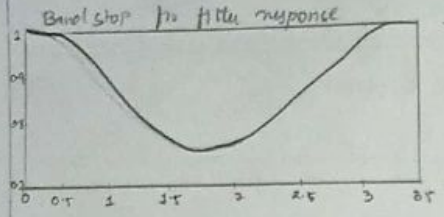
```
clc;
clear all;
close all;
N = 8
wc1 = 0.5*pi
wc2 = 0.6*pi
b = fir1 [N, [wc1/pi  wc2/pi], 'bandpass', hamming(N+1)');
disp ('b');b
w=0:.001:pi;
H= freqz (b,1,w);
subplot (1,2,1);
plot (w, abs(H)));
title ('band pass fir filter response');
subplot (1,2,2);
plot(w,angle(H));
title ('phase plot');
```

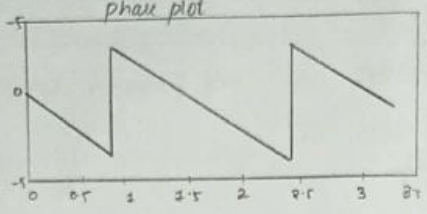
Result:

b = 0.0277 0.0430 -0.2311 -0.0617 0.4574 -0.0617

-0.2311 -0.0430 -0.0277

Roll No. : ..... Lecturer's Signature : .....





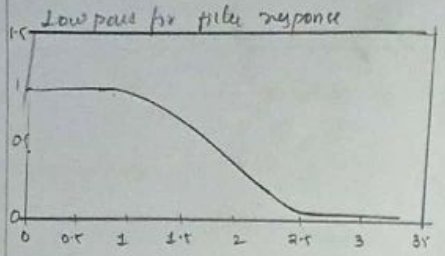
Expt. No. ..... Page No. 50 Date : .....

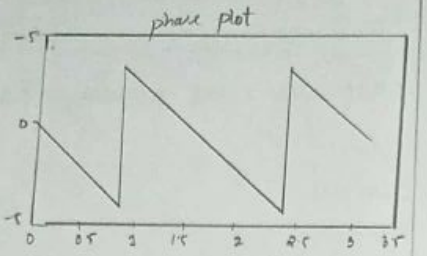
```
% BRF with cutoff frequency 0.5 pi & order = 8.
clc;
clear all;
close all;
N = 8;
wc1 = 0.5*pi;
wc2 = 0.6*pi;
b = fir1 (N, [wc1/pi wc2/pi], 'stop', hamming (N+1));
disp ('b'); b
w = 0: .001 : pi;
H = freqz (b,1,w);
subplot (1,2,1);
plot ( w, abs(H));
title ('band stop fir filter response');
subplot (1,2,2);
plot ( w, angle(H));
title ('phase plot');
```

Result:

-0.0061 -0.0094 0.0507 -0.0135 0.9026 0.0135
0.0507 -0.0094 -0.0061

Roll No. : ..... Lecturer's Signature : .....





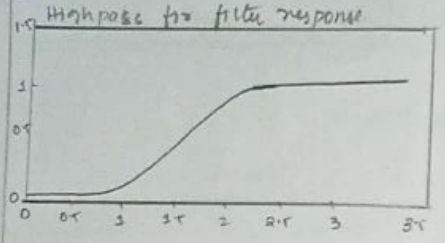
% FIR filter using Triangle window

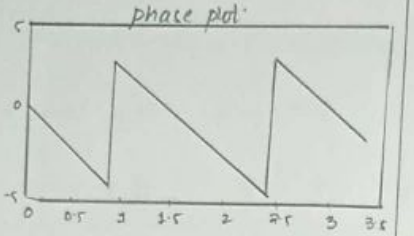
% LPF with cut-off frequency 0.5pi and order = 8.

```
clc;
clear all;
close all;
N=8;
wc = 0.5 * pi;
b = fir1 (N, (wc/pi), triang(N+1));
disp ('b'), b
w = 0:.001 : pi;
H = freqz (b,1,w).
subplot (1,2,1);
plot ( w, abs(H));
title ('Low pass FIR filter response');
subplot (1,2,2);
plot ( w, angle (H));
title ('phase plot');
```

Result:

```
b =
  -0.0000   -0.0459    0.0000    0.2755    0.5409    0.2755    0.0000
  -0.0459   -0.0000
```





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% HPF with cut off frequency 0.5 pi & order = 8.

```
clc;
Clearall;
closeall;
N= 8;
Wc= 0.5 * pi;
b= fir1 (N,(Wc/pi), 'high', triang (N+1));
disp ('b'), b
w= 0 : .001 : pi;
H= freqz (b,1,w);
Subplot (1,2,1);
plot ( w, abs(H));
title ('high pass fir filter response');
Subplot (1,2,2))
Plot ( w, angle (H));
title ( 'phase plot');
```

Result:

-0.0000 0.0459 -0.0000 -0.2755 0.5409 -0.2755

-0.0000 0.0459 -0.0000

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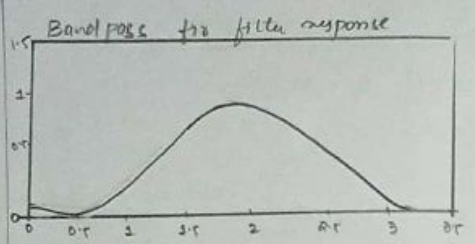

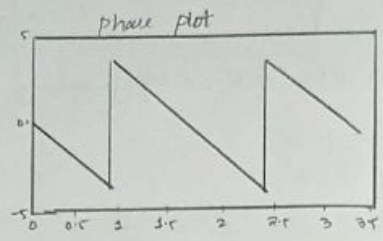

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```
% BPF with cutoff frequency 0.5 pi & order = 8
clc;
Clear all;
Close all;
N=8;
wc1 = 0.5* pi;
wc2 = 0.6* pi;
b= fir1( N, [wc1/pi wc2/pi], 'bandpass', triang (N+1));
disp ('b'); b
w= 0: .001: pi;
H= freqz (b,1,w);
Subplot (1,2,1);
Plot (w, abs(H));
title ('bandpass fir filter response');
Subplot (1,2,2);
plot (w, angle (H));
title ('phase plot');
```

Result:

b =

0.0603 0.0697 -0.2236 -0.0496 0.3983 -0.0496

-0.2236 0.0697 0.0603

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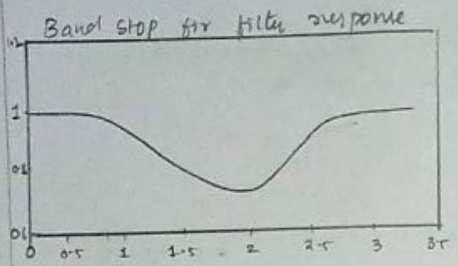
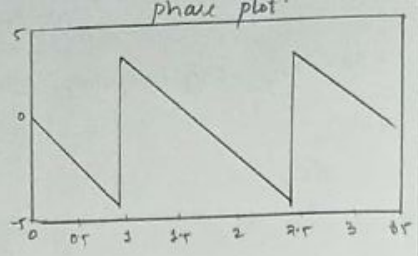




v. BRF with cutoff frequency 0.5pi & order = 8.

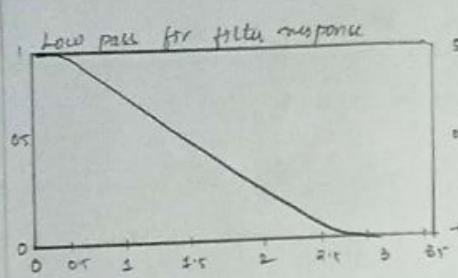
```
CLC;
Clear all;
Close all;
N=8;
wc1= 0.5*pi;
wc2 = 0.6* pi;
b= fir1 [N, [wc1/pi . wc2/pi], 'stop', triang (N+1));
disp ('b'), b.
w=0:.001 : pi;
H= freqz (b,1,w);
Subplot (1,2,1);
plot ( w, abs(H));
title ('band stop fir filter response');
subplot (1,2,2);
plot (w,angle(H));
title ('phase plot');
```

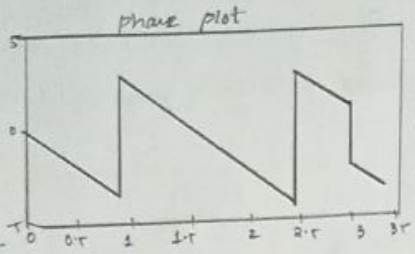
Result:

b=

-0.0156 -0.0180 0.0578 0.0128 0.926 0.0128 0.0578

-0.0180 -0.0156.





% FIR filter using hanning window

% LPF with cutoff frequency 0.5 pi and order = 8

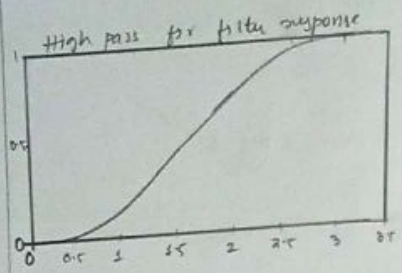
```
clc;
clear all;
close all;
N=8
wc = 0.5*pi;
b= fir1 (N,(wc/pi), hann (N+1));
disp ('b');b.
w = 0: .001 : pi;
H = freqz (b,1,w);
subplot (1,2,1);
plot ( w, abs (H));
title ('Low pass FIR filter response');
subplot (1,2,2);
plot ( w, angle (H));
title ('phase plot');
```

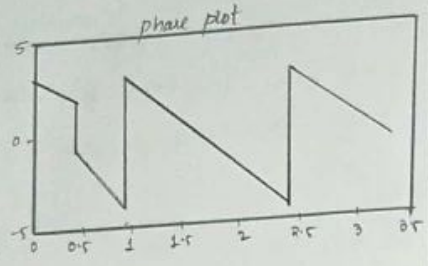
Result:

b: ~~-0.0193~~ -0.0153

0.0000 -0.0153 0.0000 0.2684 0.4939 0.0000 ~~0.0000~~

0.0000





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% HPF with cutoff frequency 0.5 pi & other = 8

```
clc;
clear all;
close all;

N=8;
w= 0.5*pi;
b= fir1 (N, (w/pi), 'high', hann (N+1));
disp ('b'); b

w= 0: .001 : pi;
H= freqz (b,1,w);
subplot (1,2,1);
plot ( w, abs (H));
title ('high pass fir filter response');
subplot (1,2,2);
plot (w, angle(H));
title ('phase plot');
```

Result:

```
b=
  0.0000   0.0153   -0.0000   -0.2684   0.4939   -0.2684

  -0.0000   0.0153   0.0000
```

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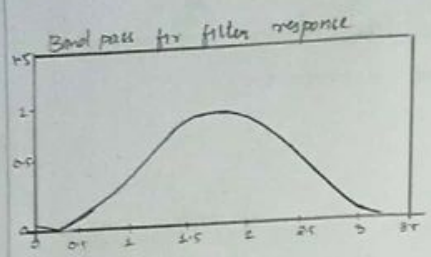
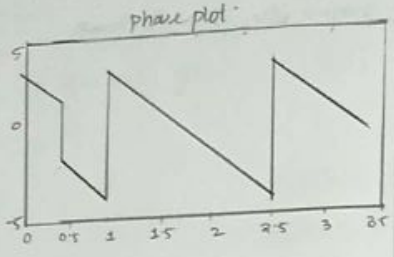


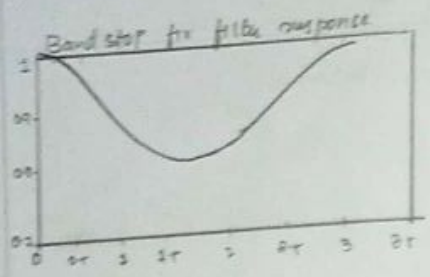


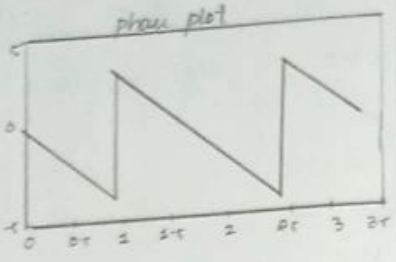

```
%. BPF with cutoff frequency 0.5pi & order=8

clc;
clear all;
close all;

N=8;
wc1 = 0.5*pi;
wc2 = 0.6*pi;
b = fir1(N, [wc1/pi wc2/pi], 'bandpass', hann(N+1));

disp('b');b.
w = 0:.001:pi;
H = freqz(b,1,w);
subplot(1,2,1);
plot(w, abs(H))
title('band pass fir filter response');
subplot(1,2,2);
plot(w, angle(H));
title('phase plot');
```

Result:

b. 0.0000 0.0322 −0.2351 −0.0668 0.5026 −0.0668

−0.2351 0.0322 0.0000



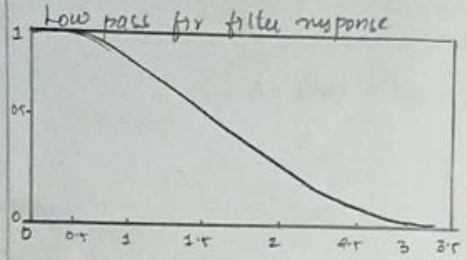


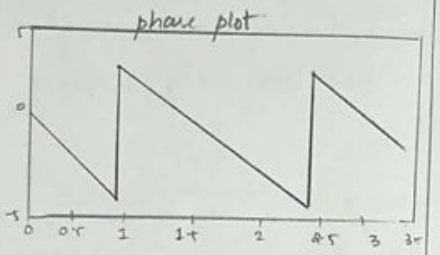

```
% BRF with cut off frequency 0.5 pi & order = 8

clc;
clear all;
closeall;
N=8;
wc1 = 0.5*pi;
wc2 = 0.6* pi;
b = fir1 (N, [wc1/pi wc2/pi], 'stop', hann(N+1));
disp('b'); b
w = 0:.001: pi;
H = freqz (b,1,w);
subplot (1,2,1);
plot (w, abs(H));
title ('band stop fir filter response');
subplot (1,2,2);
plot(w,angle(H));
title ('phase plot');
```

Result:

b = 0.0000 -0.0064 0.0464 0.0132 0.8934 0.0132

0.0464 -0.0064 0.0000





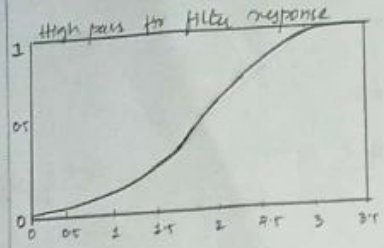
Y. FIR filter using Blackman window.

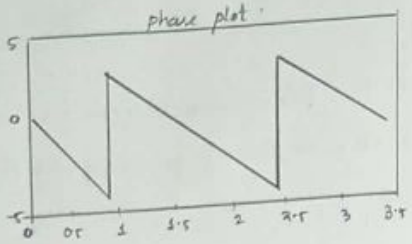
% LPF with cut-off frequency 0.5 pi and order=8

```
CLC;
Clear all;
Close all;
N=8;
Wc = 0.5* pi;
b= fir1 (N, (wc/pi), blackman(N+1));
disp ('b'), b
w= 0 : .001 : pi;
H= freqz (b,1,w)
subplot (1,2,1);
plot ( w, abs(H));
title ('Low pass FIR filter response');
subplot (1,2,2);
plot ( w, angle(H));
title ('phase plot');
```

Result:

```
b=
0.0000   -0.0072   0.0000   0.2517   0.5111   0.2517   0.0000

-0.0072   0.0000
```





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Y. HPF with cutoff frequency 0.5pi & order=8

```
clc;
clear all;
close all;
N=8;
wc = 0.5*pi;
b= fir1 (N, (wc/pi) ,'high' ,blackman(N+1));
disp ('b');b.
w= 0: .001 : pi;
H= freqz (b,1,w);
subplot (1,2,1);
plot ( w, abs(H));
title ( 'high pass fir filter response');
subplot (1,2,2);
plot (w, angle(H));
title ('phase plot');
```

Result:

b =

0.0000 0.0072 −0.0000 −0.2517 0.5111 −0.2517 −0.0000

0.0072 0.0000

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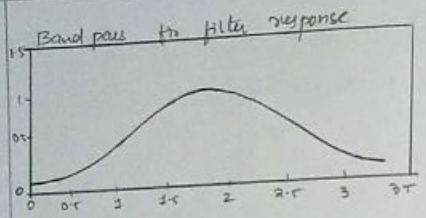

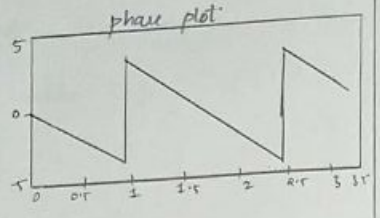

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4- BPF with cut off frequency 0.5 pi & order = 8.

```
clc;
clear all
close all;

N=8;
wc1= 0.5* pi;
wc2 =0.6* pi;
b= fir1(N, [wc1/pi wc2/pi] ,'band pass',blackman(N+1));
disp('b',b
w= 0: .001 : pi;
H= freqz (b,1,w);
subplot (1,2,1);
plot (w,abs(H));
title ('band pass fir filter response');
subplot (1,2,2);
plot (w,angle(H));
title ('phase plot');
```

Result:

```
b=
 0.0000   0.0174   -0.1906   -0.0722   0.5991   -0.0722

-0.1906   0.0174   0.0000.
```

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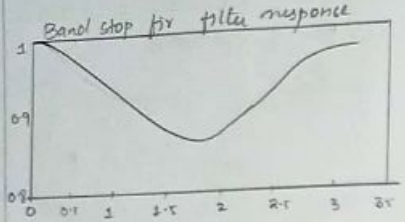

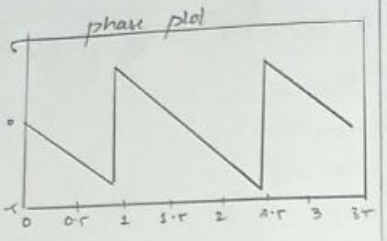

V. BRF with cutoff frequency 0.5 pi & order=8

```
clc;
clear all;
close all;
N=8;
wc1 = 0.5*pi;
wc2 = 0.6*pi;
b= fir1(N, [wc1/pi wc2/pi], 'stop', blackman(N+1));
disp('b'), b
w= 0:.001: pi;
H = freqz(b,1,w);
subplot(1,2,1);
plot(w, abs(H));
title('band stop fir filter response');
subplot(1,2,2);
plot(w, angle(H));
title('phase plot');
```

Result:

```
b=
 0.0000   -0.0030   -0.0324    0.0123    0.9166    0.0123

 0.0324   -0.0030    0.0000.
```