EXPERIMENT 8

By,

Raja Aadhithan

19/1031

Write a MATLAB Script to find the impulse response and step response of the designed FIR and IIR filters(in Lab6 and Lab7) .

%Write a MATLAB Script to design the FIR filter using Window Method. %1. Rectangular (rectwin) 2. Hamming 3. Hann 4. Kaiser

Code:

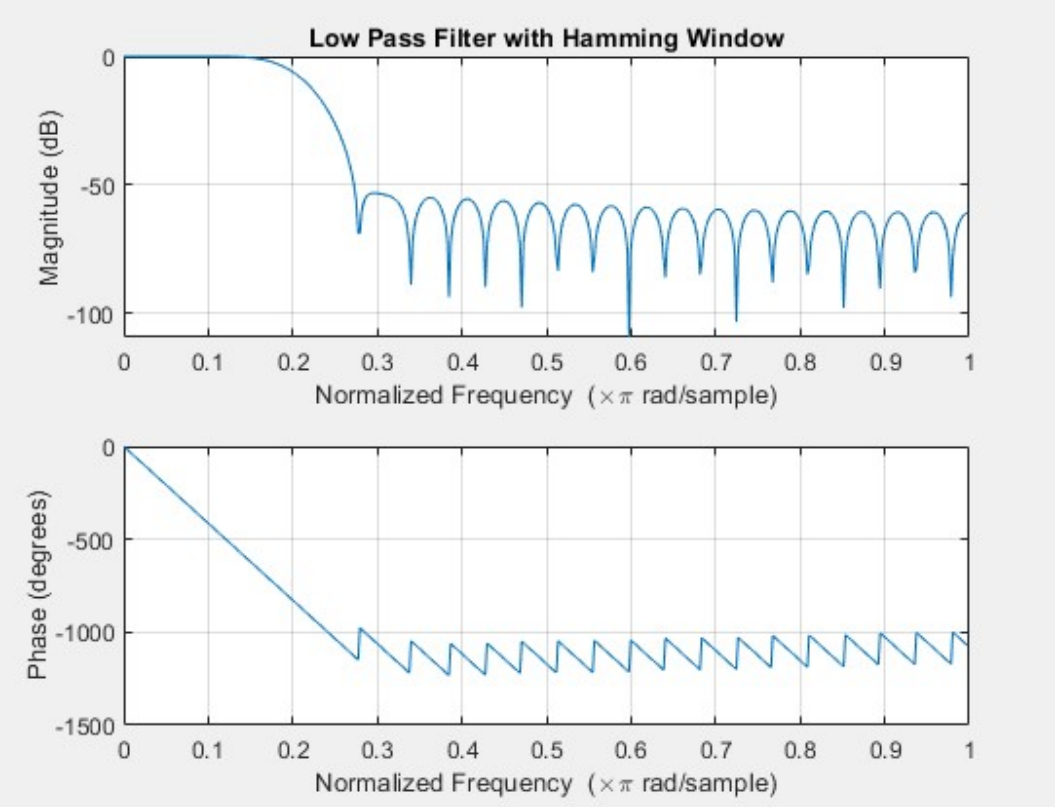
```
clc;
clear;
close all;
type = input('Enter the type of filter-1.Low Pass,2. High Pass,3.Band Pass,4. Band Stop:
');
win = input('Enter the type of window- 1.Rectangular, 2.Hamming, 3.Hann,4. Kaiser: ');
n = input('Enter the order of the filter: ');

if(type == 1)
 n1 = input('Enter the cutoff frequency(in multiples of pi) : ');
 if(win == 1)
 fil = fir1(n,n1,'low',rectwin(n+1));
 freqz(fil,1);
 title('Low Pass Filter with Rectangular Window');

 elseif(win == 2)
 fil = fir1(n,n1,'low',hamming(n+1));
 freqz(fil,1);
 title('Low Pass Filter with Hamming Window');

 elseif(win == 3)
 fil = fir1(n,n1,'low',hann(n+1));
 freqz(fil,1);
 title('Low Pass Filter with Hann Window');

 elseif(win == 4)
 fil = fir1(n,n1,'low',kaiser(n+1));
 freqz(fil,1);
 title('Low Pass Filter with Kaiser Window');
 end
elseif(type == 2)
 n1 = input('Enter the cutoff frequency(in multiples of pi) : ');
 if(mod(n,2))
 n=n+1;
 end
 if(win == 1)
 fil = fir1(n,n1,'high',rectwin(n+1));
 freqz(fil,1);
 title('High Pass Filter with Rectangular Window');

 elseif(win == 2)
 fil = fir1(n,n1,'high',hamming(n+1));
 freqz(fil,1);
 title('High Pass Filter with Hamming Window');
```

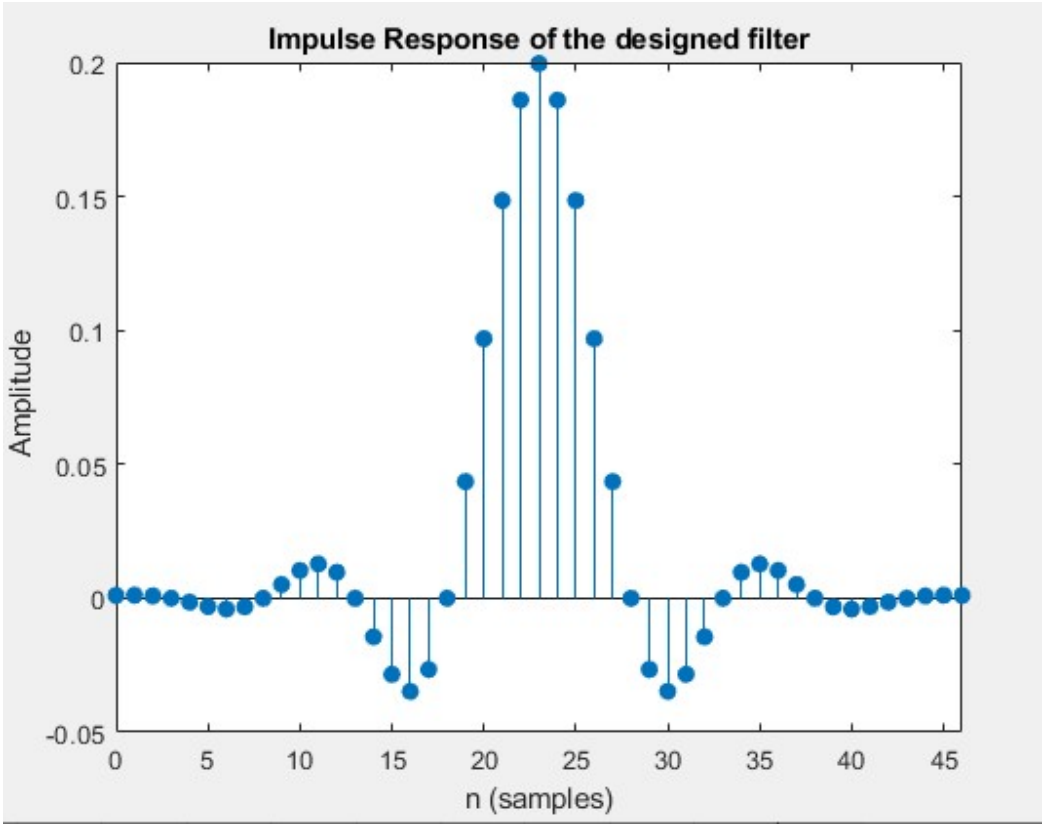
```
 elseif(win == 3)
 fil = fir1(n,n1,'high',hann(n+1));
 freqz(fil,1);
 title('High Pass Filter with Hann Window');

 elseif(win == 4)
 fil = fir1(n,n1,'high',kaiser(n+1));
 freqz(fil,1);
 title('High Pass Filter with Kaiser Window');
 end

elseif(type == 3)
 n1 = input('Enter the first cutoff frequency(in multiples of pi): ');
 n2 = input('Enter the second cutoff frequency(in multiples of pi): ');
 if(win == 1)
 fil = fir1(n,[n1 n2],'bandpass',rectwin(n+1));
 freqz(fil,1);
 title('Band Pass Filter with Rectangular Window');

 elseif(win == 2)
 fil = fir1(n,[n1 n2],'bandpass',hamming(n+1));
 freqz(fil,1);
 title('Band Pass Filter with Hamming Window');

 elseif(win == 3)
 fil = fir1(n,[n1 n2],'bandpass',hann(n+1));
 freqz(fil,1);
 title('Band Pass Filter with Hann Window');

 elseif(win == 4)
 fil = fir1(n,[n1 n2],'bandpass',kaiser(n+1));
 freqz(fil,1);
 title('Band Pass Filter with Kaiser Window');
 end
elseif(type == 4)
 n1 = input('Enter the first cutoff frequency(in multiples of pi): ');
 n2 = input('Enter the second cutoff frequency(in multiples of pi): ');
 if(mod(n,2))
 n=n+1;
 end
 if(win == 1)
 fil = fir1(n,[n1 n2],'stop',rectwin(n+1));
 freqz(fil,1);
 title('Band Stop Filter with Rectangular Window');

 elseif(win == 2)
 fil = fir1(n,[n1 n2],'stop',hamming(n+1));
 freqz(fil,1);
 title('Band Stop Filter with Hamming Window');

 elseif(win == 3)
 fil = fir1(n,[n1 n2],'stop',hann(n+1));
 freqz(fil,1);
 title('Band Stop Filter with Hann Window');

 elseif(win == 4)
 fil = fir1(n,[n1 n2],'stop',kaiser(n+1));
 freqz(fil,1);
 title('Band Stop Filter with Kaiser Window');
 end
```

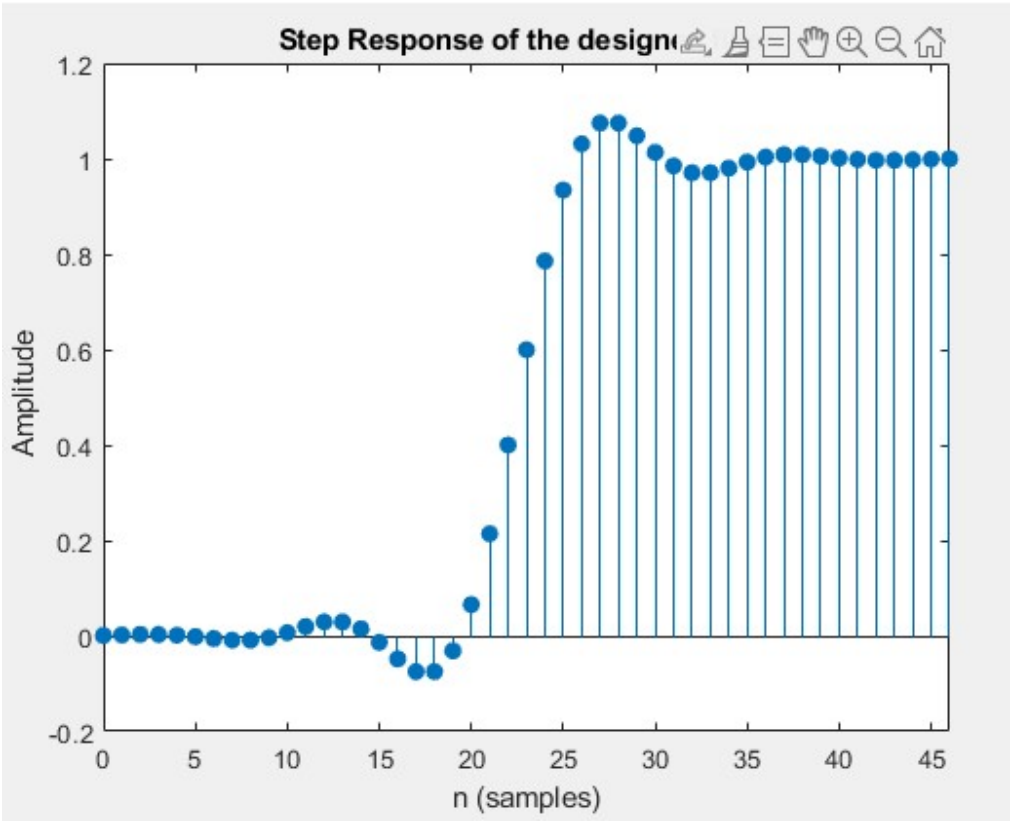
```
end
figure(2);
impz(fil);
title('Impulse Response of the designed filter');
figure(3);
stepz(fil);
title('Step Response of the designed filter');
```

Output:

```
Enter the type of filter-1.Low Pass,2. High Pass,3.Band Pass,4. Band Stop: 1
Enter the type of window- 1.Rectangular, 2.Hamming, 3.Hann,4. Kaiser: 2
Enter the order of the filter: 46
Enter the cutoff frequency(in multiples of pi) : .2
```




Impulse Response of the designed filter
Amplitude
n (samples)
0.2
0.15
0.1
0.05
0
-0.05
0
5
10
15
20
25
30
35
40
45


Step Response of the design
Amplitude
n (samples)
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
0
5
10
15
20
25
30
35
40
45

Write a MATLAB Script to design the Butterworth, Chebyshev and Elliptic filters based on 1. Bilinear Transformation 2. Impulse Invariant Transformation (Lab 7)

Code:

```
%Write a MATLAB Script to design the Butterworth, Chebyshev and Elliptic filters based on
% Bilinear Transformation and Impulse Invariant Transformation
clc;
clear;
close all;
type = input('Enter the type of filter- 1.Low Pass, 2.High Pass, 3.Band Pass, 4.Band
Stop: ');
g = input('Enter the design of filter- 1.Butterworth, 2.Chebyshev type1, 3.Chebyshev
type2, 4.Elliptic: ');
k = input('Enter the type of Filter discretization functions1.Bilinear, 2.Impulse
Invariant: ');
rp = input('Enter the pass band ripple: ');
rs = input('Enter the stop band attenuation: ');
wp = input('Enter the pass band frequency(Hz): ');
ws = input('Enter the stop band frequency(Hz): ');
fs = input('Enter the sampling frequency(Hz): ');
wp = wp/(fs/2);
ws = ws/(fs/2);
if(type == 1)
 if(g == 1)
 [n,wn] = buttord(wp,ws,rp,rs);
 [b,a] = butter(n,wn,'low');
 if(k ==1)
 [bz,az] = bilinear(b,a,fs);
 elseif(k==2)
 [bz,az] = impinvar(b,a,fs);
 end
 freqz(bz,az,1024,fs);
 title(sprintf('n = %d Digital Low Pass Butterworth Filter',n));
 figure(2);
 freqz(b,a,1024,fs);
 title(sprintf('n = %d Analog Low Pass Butterworth Filter',n));

 elseif(g == 2)
 [n,wp] = cheb1ord(wp,ws,rp,rs);
 [b,a] = cheby1(n,rp,wp,'low');
 if(k ==1)
 [bz,az] = bilinear(b,a,fs);
 elseif(k==2)
 [bz,az] = impinvar(b,a,fs);
 end
 freqz(bz,az,1024,fs);
 title(sprintf('n = %d Digital Low Pass Chebyshev Type 1 Filter',n));
 figure(2);
 freqz(b,a,1024,fs);
 title(sprintf('n = %d Analog Low Pass Chebyshev Type 1 Filter',n));

 elseif(g == 3)
 [n,ws] = cheb2ord(wp,ws,rp,rs);
 [b,a] = cheby2(n,rs,ws,'low');
 if(k ==1)
 [bz,az] = bilinear(b,a,fs);
 elseif(k==2)
 [bz,az] = impinvar(b,a,fs);
 end
 freqz(bz,az,1024,fs);
 title(sprintf('n = %d Digital Low Pass Chebyshev Type 2 Filter',n));
```

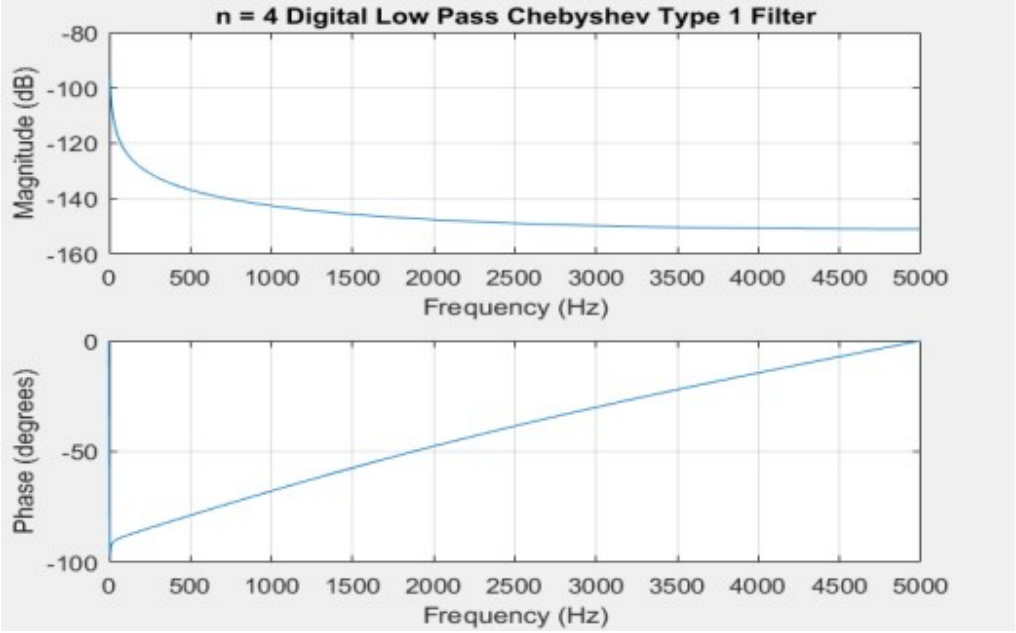
```
 figure(2);
 freqz(b,a,1024,fs);
 title(sprintf('n = %d Analog Low Pass Chebyshev Type 2 Filter',n));

 elseif(g == 4)
 [n,wp] = ellipord(wp,ws,rp,rs);
 [b,a] = ellip(n,rp,rs,wp,'low');
 if(k ==1)
 [bz,az] = bilinear(b,a,fs);
 elseif(k==2)
 [bz,az] = impinvar(b,a,fs);
 end
 freqz(bz,az,1024,fs);
 title(sprintf('n = %d Digital Low Pass Elliptic Filter',n));
 figure(2);
 freqz(b,a,1024,fs);
 title(sprintf('n = %d Analog Low Pass Elliptic Filter',n));
 end
elseif(type == 2)
 if(g == 1)
 [n,wn] = buttord(wp,ws,rp,rs);
 [b,a] = butter(n,wn,'high');
 if(k ==1)
 [bz,az] = bilinear(b,a,fs);
 elseif(k==2)
 [bz,az] = impinvar(b,a,fs);
 end
 freqz(bz,az,1024,fs);
 title(sprintf('n = %d Digital High Pass Butterworth Filter',n));
 figure(2);
 freqz(b,a,1024,fs);
 title(sprintf('n = %d Analog High Pass Butterworth Filter',n));

 elseif(g == 2)
 [n,wp] = cheb1ord(wp,ws,rp,rs);
 [b,a] = cheby1(n,rp,wp,'high');
 if(k ==1)
 [bz,az] = bilinear(b,a,fs);
 elseif(k==2)
 [bz,az] = impinvar(b,a,fs);
 end
 freqz(bz,az,1024,fs);
 title(sprintf('n = %d Digital High Pass Chebyshev Type 1 Filter',n));
 figure(2);
 freqz(b,a,1024,fs);
 title(sprintf('n = %d Analog High Pass Chebyshev Type 1 Filter',n));

 elseif(g == 3)
 [n,ws] = cheb2ord(wp,ws,rp,rs);
 [b,a] = cheby2(n,rs,ws,'high');
 if(k ==1)
 [bz,az] = bilinear(b,a,fs);
 elseif(k==2)
 [bz,az] = impinvar(b,a,fs);
 end
 freqz(bz,az,1024,fs);
 title(sprintf('n = %d Digital High Pass Chebyshev Type 2 Filter',n));
 figure(2);
 freqz(b,a,1024,fs);
 title(sprintf('n = %d Analog High Pass Chebyshev Type 2 Filter',n));

 elseif(g == 4)
```

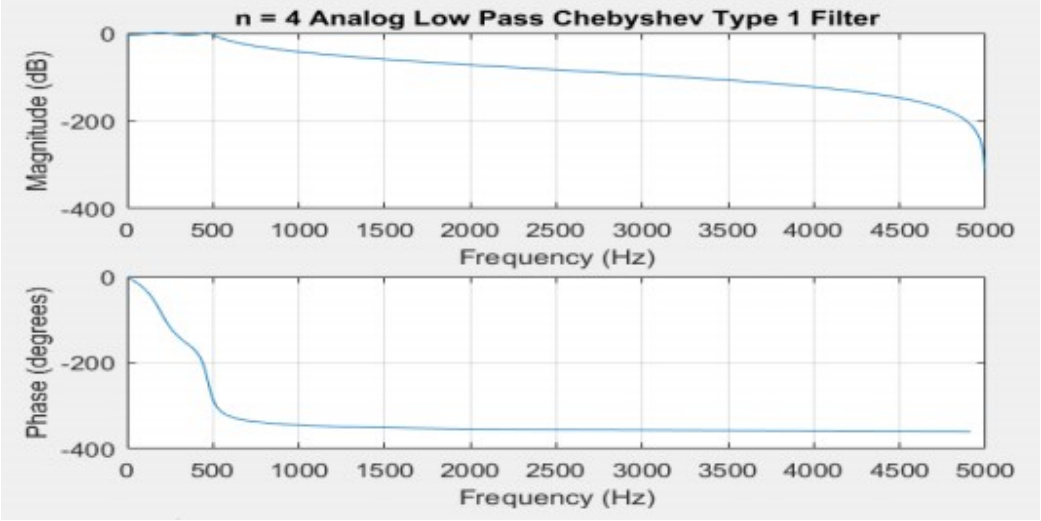
```
 [n,wp] = ellipord(wp,ws,rp,rs);
 [b,a] = ellip(n,rp,rs,wp,'high');
 if(k ==1)
 [bz,az] = bilinear(b,a,fs);
 elseif(k==2)
 [bz,az] = impinvar(b,a,fs);
 end
 freqz(bz,az,1024,fs);
 title(sprintf('n = %d Digital High Pass Elliptic Filter',n));
 figure(2);
 freqz(b,a,1024,fs);
 title(sprintf('n = %d Analog High Pass Elliptic Filter',n));
 end

elseif(type == 3)
 if(g == 1)
 [n,wn] = buttord(wp,ws,rp,rs);
 [b,a] = butter(n,wn,'bandpass');
 if(k ==1)
 [bz,az] = bilinear(b,a,fs);
 elseif(k==2)
 [bz,az] = impinvar(b,a,fs);
 end
 freqz(bz,az,1024,fs);
 title(sprintf('n = %d Digital Bandpass Butterworth Filter',n));
 figure(2);
 freqz(b,a,1024,fs);
 title(sprintf('n = %d Analog Bandpass Butterworth Filter',n));

 elseif(g == 2)
 [n,wp] = cheb1ord(wp,ws,rp,rs);
 [b,a] = cheby1(n,rp,wp,'bandpass');
 if(k ==1)
 [bz,az] = bilinear(b,a,fs);
 elseif(k==2)
 [bz,az] = impinvar(b,a,fs);
 end
 freqz(bz,az,1024,fs);
 title(sprintf('n = %d Digital Bandpass Chebyshev Type 1 Filter',n));
 figure(2);
 freqz(b,a,1024,fs);
 title(sprintf('n = %d Analog Bandpass Chebyshev Type 1 Filter',n));

 elseif(g == 3)
 [n,ws] = cheb2ord(wp,ws,rp,rs);
 [b,a] = cheby2(n,rs,ws,'bandpass');
 if(k ==1)
 [bz,az] = bilinear(b,a,fs);
 elseif(k==2)
 [bz,az] = impinvar(b,a,fs);
 end
 freqz(bz,az,1024,fs);
 title(sprintf('n = %d Digital Bandpass Chebyshev Type 2 Filter',n));
 figure(2);
 freqz(b,a,1024,fs);
 title(sprintf('n = %d Analog Bandpass Chebyshev Type 2 Filter',n));

 elseif(g == 4)
 [n,wp] = ellipord(wp,ws,rp,rs);
 [b,a] = ellip(n,rp,rs,wp,'bandpass');
 if(k ==1)
 [bz,az] = bilinear(b,a,fs);
```

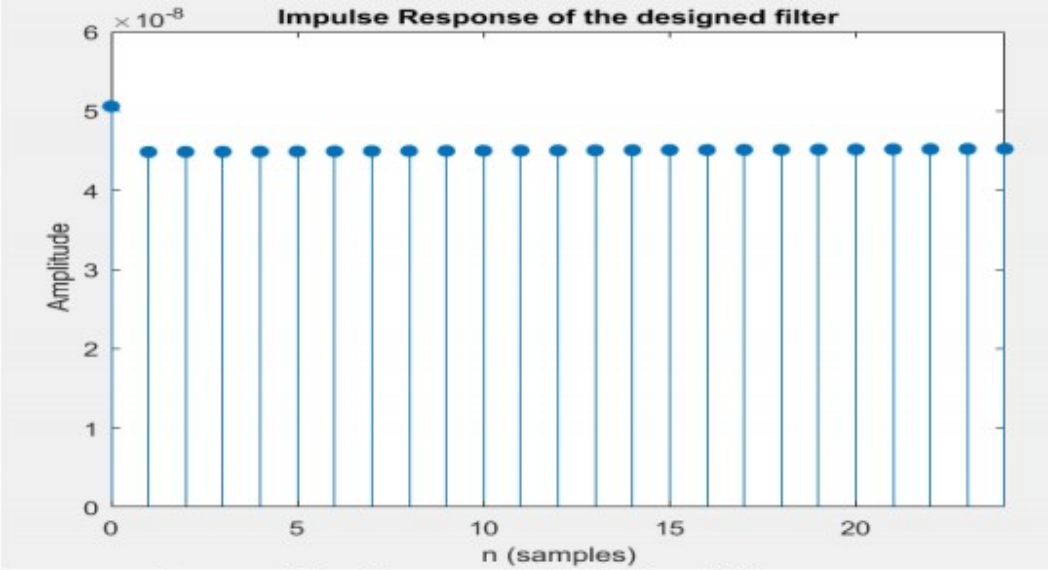
```
 elseif(k==2)
 [bz,az] = impinvar(b,a,fs);
 end
 freqz(bz,az,1024,fs);
 title(sprintf('n = %d Digital Bandpass Elliptic Filter',n));
 figure(2);
 freqz(b,a,1024,fs);
 title(sprintf('n = %d Analog Bandpass Elliptic Filter',n));
 end
elseif(type == 4)
 if(g == 1)
 [n,wn] = buttord(wp,ws,rp,rs);
 [b,a] = butter(n,wn,'stop');
 if(k ==1)
 [bz,az] = bilinear(b,a,fs);
 elseif(k==2)
 [bz,az] = impinvar(b,a,fs);
 end
 freqz(bz,az,1024,fs);
 title(sprintf('n = %d Digital Bandstop Butterworth Filter',n));
 figure(2);
 freqz(b,a,1024,fs);
 title(sprintf('n = %d Analog Bandstop Butterworth Filter',n));

 elseif(g == 2)
 [n,wp] = cheb1ord(wp,ws,rp,rs);
 [b,a] = cheby1(n,rp,wp,'stop');
 if(k ==1)
 [bz,az] = bilinear(b,a,fs);
 elseif(k==2)
 [bz,az] = impinvar(b,a,fs);
 end
 freqz(bz,az,1024,fs);
 title(sprintf('n = %d Digital Bandstop Chebyshev Type 1 Filter',n));
 figure(2);
 freqz(b,a,1024,fs);
 title(sprintf('n = %d Analog Bandstop Chebyshev Type 1 Filter',n));

 elseif(g == 3)
 [n,ws] = cheb2ord(wp,ws,rp,rs);
 [b,a] = cheby2(n,rs,ws,'stop');
 if(k ==1)
 [bz,az] = bilinear(b,a,fs);
 elseif(k==2)
 [bz,az] = impinvar(b,a,fs);
 end
 freqz(bz,az,1024,fs);
 title(sprintf('n = %d Digital Bandstop Chebyshev Type 2 Filter',n));
 figure(2);
 freqz(b,a,1024,fs);
 title(sprintf('n = %d Analog Bandstop Chebyshev Type 2 Filter',n));

 elseif(g == 4)
 [n,wp] = ellipord(wp,ws,rp,rs);
 [b,a] = ellip(n,rp,rs,wp,'stop');
 if(k ==1)
 [bz,az] = bilinear(b,a,fs);
 elseif(k==2)
 [bz,az] = impinvar(b,a,fs);
 end
 freqz(bz,az,1024,fs);
 title(sprintf('n = %d Digital Bandstop Elliptic Filter',n));
```

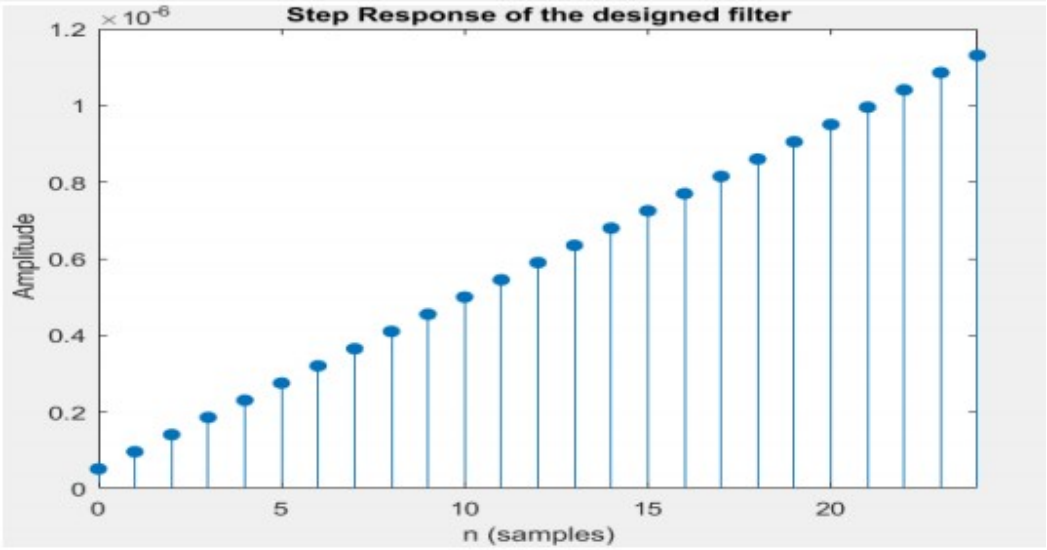
```
 figure(2);
 freqz(b,a,1024,fs);
 title(sprintf('n = %d Analog Bandstop Elliptic Filter',n));
 end

end
figure(3);
impz(bz,az,25);
title('Impulse Response of the designed filter');
figure(4);
stepz(bz,az,25);
title('Step Response of the designed filter');
```

OUTPUT:






Impulse Response of the designed filter
×10^-8
Amplitude
n (samples)
0
1
2
3
4
5
6
0
5
10
15
20


Step Response of the designed filter
×10^-6
Amplitude
n (samples)
0
0.2
0.4
0.6
0.8
1
1.2
0
5
10
15
20