**EXPERIMENT 7**

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**19/1031**

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

**Code:**

%Write a MATLAB Script to design the Butterworth, Chebyshev type-1, Chebyshev type-2 and Elliptic filters based on

%1. Bilinear Transformation

%2. Impulse Invariant Transformation

clc;

clear;

close all;

type = input('Enter the type of filter(Low Pass= 1, High Pass= 2,Band Pass= 3, Band Stop= 4): ');

g = input('Enter the design of filter( Butterworth= 1, Chebyshev type1= 2, Chebyshev type2= 3, Elliptic= 4 ): ');

k = input('Enter the type of Filter discretization functions(Bilinear= 1, Impulse Invariant= 2 ): ');

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);

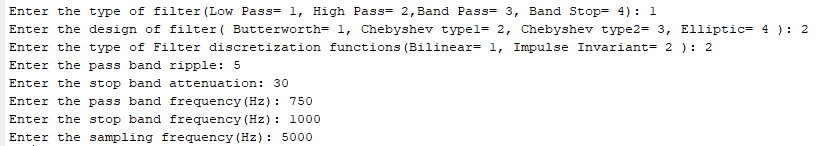
freqz(b,a,1024,fs);

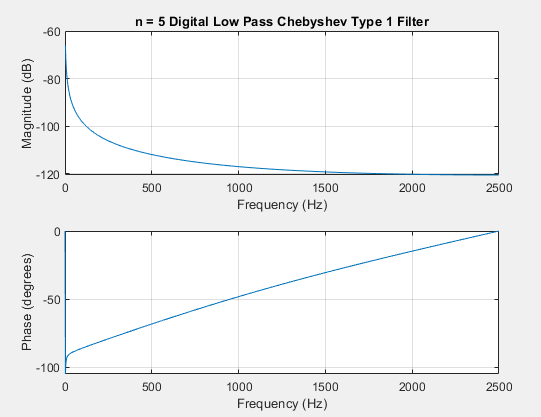
title(sprintf('n = %d Analog Bandstop Elliptic Filter',n));

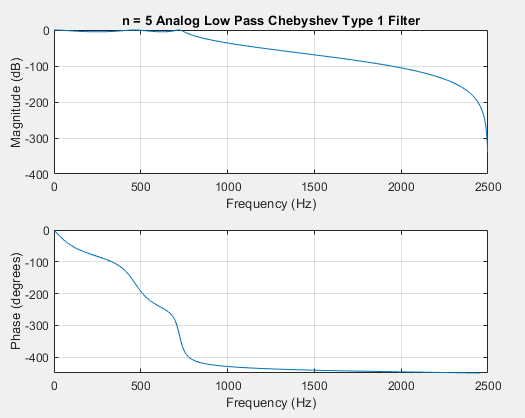
end

end

**Output :**

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