EXP 8 ***IIR FILTERS***

14/8/14

AIM:

To design IIR filters in Matlab.

PROGRAM:

*IIR LOW PASS FILTER*

clc;

clear all;

close all;

fprintf('\nDIGITAL FILTER SPECIFICATIONS\n');

passfreq=input('Enter the passband frequency(hz) ');

stopfreq=input('Enter the stopband frequency(hz) ');

passatt=input('Enter the passband attenuation(db) ');

stopatt=input('Enter the stopband attenuation(db) ');

FS=input('ENTER THE SAMPLING FREQUENCY ');

TS=1/FS;

opassfreq=(2/TS)\*tan(pi\*passfreq\*TS);

ostopfreq=(2/TS)\*tan(pi\*stopfreq\*TS);

lambda=sqrt((10^(stopatt/10))-1);

ebsi=sqrt((10^(passatt/10))-1);

N=log(lambda/ebsi)/log(ostopfreq/opassfreq);

N=ceil(N);

fprintf('\nThe order of the filter is %d',N);

cf=opassfreq/(ebsi^(1/N));

fprintf('\nThe cut-off frequency is %d',cf);

for k=1:N

phi=(pi/2)+(((2\*k-1)\*pi)/(2\*N));

p(k)=exp(1i\*phi);

end

fprintf('\nTHE POLES ARE ');

disp(p);

p=p\*cf;

k=cf^(numel(p));

z=[];

[nums,dens]=zp2tf(z,p,k);

[numz,denz]=bilinear(nums,dens,FS);

[FR,W]=freqz(numz,denz);

subplot(3,1,1);

plot(W./pi,((abs(FR))));

xlabel('FREQUENCY');

ylabel('MAGNITUDE');

title('FREQUENCY RESPONSE');

subplot(312);

plot(W./pi,angle(FR));

ylabel('PHASE IN RADIANS');

xlabel('NORMALISED FREQUENCY');

[IR,t]=impz(numz,denz);

subplot(313);

plot(t/pi,IR);

title('IMPULSE RESPONSE');

OUTPUT:

DIGITAL FILTER SPECIFICATIONS

Enter the passband frequency(hz) 400

Enter the stopband frequency(hz) 800

Enter the passband attenuation(db) 0.4

Enter the stopband attenuation(db) 30

ENTER THE SAMPLING FREQUENCY 2000

The order of the filter is 4

The cut-off frequency is 3.892847e+003

THE POLES ARE

-0.3827 + 0.9239i ,-0.9239 + 0.3827i ,-0.9239 - 0.3827i, -0.3827 - 0.9239i





*IIR HIGH PASS FILTER*

clc;

clear all;

close all;

fprintf('\nDIGITAL FILTER SPECIFICATIONS\n');

passfreq=input('Enter the passband frequency(hz) ');

stopfreq=input('Enter the stopband frequency(hz) ');

passatt=input('Enter the passband attenuation(db) ');

stopatt=input('Enter the stopband attenuation(db) ');

FS=input('ENTER THE SAMPLING FREQUENCY ');

TS=1/FS;

temp=passfreq;

passfreq=stopfreq;

stopfreq=temp;

opassfreq=(2/TS)\*tan(pi\*passfreq\*TS);

ostopfreq=(2/TS)\*tan(pi\*stopfreq\*TS);

lambda=sqrt((10^(stopatt/10))-1);

ebsi=sqrt((10^(passatt/10))-1);

N=log10(lambda/ebsi)/log10(ostopfreq/opassfreq);

N=ceil(N);

fprintf('\nThe order of the filter is %d',N);

cf=ostopfreq/(ebsi^(1/N));

fprintf('\nThe cut-off frequency is %d',cf);

for k=1:N

phi=(pi/2)+(((2\*k-1)\*pi)/(2\*N));

p(k)=exp(sqrt(-1)\*phi);

end

fprintf('\nTHE POLES ARE ');

disp(p);

b=[zeros(1,N),1];

syms s b1 a1;

syms f

if rem(N,2)==0

for i=1:(N/2)

f=(s^2 + b1\*s + 1);

a1(i)=2\*sin(((2\*i-1)\*pi)/(2\*N));

hn(i)=subs(f,b1,a1(i));

end

else

for i=1:((N-1)/2)

f=(s+1)\*(s^2+b1\*s+1);

a1(i)=2\*sin(((2\*i-1)\*pi)/(2\*N));

hn(i)=subs(f,b1,a1(i));

end

end

h=1;

for g=1:i

h=h\*hn(g);

end

a=fliplr(sym2poly(coeffs(h,s)));

[bh,ah]=lp2hp(b,a,cf);

[numz,denz]=bilinear(bh,ah,FS);

[FR,W]=freqz(numz,denz);

figure

set(gca, 'FontSize', 16)

plot(W./pi,((abs(FR))));

xlabel('NORMALISED FREQUENCY');

ylabel('MAGNITUDE')

title('FREQUENCY RESPONSE');

figure

set(gca, 'FontSize', 16)

plot(W./pi,angle(FR));

ylabel('PHASE IN RADIANS');

xlabel('NORMALISED FREQUENCY');

[IR,t]=impz(numz,denz);

figure

set(gca, 'FontSize', 16)

plot(t/pi,IR);

title('IMPULSE RESPONSE');

OUTPUT:

DIGITAL FILTER SPECIFICATIONS

Enter the passband frequency(hz) 800

Enter the stopband frequency(hz) 400

Enter the passband attenuation(db) 0.4

Enter the stopband attenuation(db) 30

ENTER THE SAMPLING FREQUENCY 2000

The order of the filter is 4

The cut-off frequency is 1.649037e+004

THE POLES ARE

-0.3827 + 0.9239i ,-0.9239 + 0.3827i ,-0.9239 - 0.3827i ,-0.3827 - 0.9239i





*IIR BAND PASS FILTER*

clc;

clear all;

close all;

fprintf('\nDIGITAL BAND PASS FILTER SPECIFICATIONS\n');

w1=input('ENTER THE VALUE FOR w1(hz) ');

wL=input('ENTER THE VALUE FOR wL(hz) ');

wU=input('ENTER THE VALUE FOR wU(hz) ');

w2=input('ENTER THE VALUE FOR w2(hz) ');

FS=input('ENTER THE SAMPLING FREQUENCY');

passatt=input('Enter the passband attenuation(db) ');

stopatt=input('Enter the stopband attenuation(db) ');

TS=1/FS;

lambda=sqrt((10^(stopatt/10))-1);

ebsi=sqrt((10^(passatt/10))-1);

ow1=(2/TS)\*tan(pi\*w1\*TS);

owL=(2/TS)\*tan(pi\*wL\*TS);

owU=(2/TS)\*tan(pi\*wU\*TS);

ow2=(2/TS)\*tan(pi\*w2\*TS);

a3=owL\*owU;

b3=owU-owL;

A=(-(ow1^2)+a3)/(ow1\*b3);

B=((ow2^2)-a3)/(ow2\*b3);

owr=min(abs(A),abs(B));

opassfreq=1;

ostopfreq=owr;

N=log10(lambda/ebsi)/log10(ostopfreq/opassfreq);

N=ceil(N);

fprintf('\nThe order of the filter is %d',N);

for k=1:N

phi=(pi/2)+(((2\*k-1)\*pi)/(2\*N));

p(k)=exp(sqrt(-1)\*phi);

end

fprintf('\nTHE POLES ARE ');

disp(p);

b=[zeros(1,N),1];

syms s b1 a1;

syms f

if rem(N,2)==0

for i=1:(N/2)

f=(s^2 + b1\*s + 1);

a1(i)=2\*sin(((2\*i-1)\*pi)/(2\*N));

hn(i)=subs(f,b1,a1(i));

end

else

for i=1:((N-1)/2)

f=(s+1)\*(s^2+b1\*s+1);

a1(i)=2\*sin(((2\*i-1)\*pi)/(2\*N));

hn(i)=subs(f,b1,a1(i));

end

end

h=1;

for g=1:i

h=h\*hn(g);

end

a=fliplr(sym2poly(coeffs(h,s)));

[bh,ah]=lp2bp(b,a,sqrt(a3),b3);

[numz,denz]=bilinear(bh,ah,FS);

[FR,W]=freqz(numz,denz);

figure

set(gca, 'FontSize', 16)

plot(W./pi,((abs(FR))));

xlabel('NORMALISED FREQUENCY');

ylabel('MAGNITUDE')

title('FREQUENCY RESPONSE');

figure

set(gca, 'FontSize', 16)

plot(W./pi,angle(FR));

ylabel('PHASE IN RADIANS');

xlabel('NORMALISED FREQUENCY');

[IR,t]=impz(numz,denz);

figure

set(gca, 'FontSize', 16)

plot(t/pi,IR);

title('IMPULSE RESPONSE');

OUTPUT:

DIGITAL BAND PASS FILTER SPECIFICATIONS

ENTER THE VALUE FOR w1(hz) 400

ENTER THE VALUE FOR wL(hz) 800

ENTER THE VALUE FOR wU(hz) 1600

ENTER THE VALUE FOR w2(hz) 2000

ENTER THE SAMPLING FREQUENCY8000

Enter the passband attenuation(db) 2

Enter the stopband attenuation(db) 20

The order of the filter is 4

THE POLES ARE -0.3827 + 0.9239i -0.9239 + 0.3827i -0.9239 - 0.3827i -0.3827 - 0.9239i





*IIR BAND STOP FILTER*

clc;

clear all;

close all;

fprintf('\nDIGITAL BAND STOP FILTER SPECIFICATIONS\n');%200 250 300 350 2 20

wL=input('ENTER THE VALUE FOR wL(hz) ');

w1=input('ENTER THE VALUE FOR w1(hz) ');

w2=input('ENTER THE VALUE FOR w2(hz) ');

wU=input('ENTER THE VALUE FOR wU(hz) ');

FS=input('ENTER THE SAMPLING FREQUENCY ');

passatt=input('Enter the passband attenuation(db) ');

stopatt=input('Enter the stopband attenuation(db) ');

TS=1/FS;

lambda=sqrt((10^(stopatt/10))-1);

ebsi=sqrt((10^(passatt/10))-1);

owL=(2/TS)\*tan(pi\*wL\*TS);

ow1=(2/TS)\*tan(pi\*w1\*TS);

ow2=(2/TS)\*tan(pi\*w2\*TS);

owU=(2/TS)\*tan(pi\*wU\*TS);

a3=owL\*owU;

b3=owU-owL;

A=(ow1\*b3)/(-(ow1^2)+a3);

B=(ow2\*b3)/(-(ow2^2)+a3);

owr=min(abs(A),abs(B));

opassfreq=1;

ostopfreq=owr;

N=log10(lambda/ebsi)/log10(ostopfreq/opassfreq);

N=ceil(N);

fprintf('\nThe order of the filter is %d',N);

for k=1:N

phi=(pi/2)+(((2\*k-1)\*pi)/(2\*N));

p(k)=exp(sqrt(-1)\*phi);

end

fprintf('\nTHE POLES ARE ');

disp(p);

b=[zeros(1,N),1]

syms s b1 a1;

syms f

if rem(N,2)==0

for i=1:(N/2)

f=(s^2 + b1\*s + 1);

a1(i)=2\*sin(((2\*i-1)\*pi)/(2\*N))

hn(i)=subs(f,b1,a1(i))

end

else

for i=1:((N-1)/2)

f=(s+1)\*(s^2+b1\*s+1);

a1(i)=2\*sin(((2\*i-1)\*pi)/(2\*N));

hn(i)=subs(f,b1,a1(i));

end

end

h=1;

for g=1:i

h=h\*hn(g);

end

a=fliplr(sym2poly(coeffs(h,s)));

[bs,as]=lp2bs(b,a,sqrt(a3),b3);

[numz,denz]=bilinear(bs,as,FS);

[FR,W]=freqz(numz,denz);

figure

set(gca, 'FontSize', 16)

plot(W./pi,((abs(FR))));

xlabel('NORMALISED FREQUENCY');

ylabel('MAGNITUDE')

title('FREQUENCY RESPONSE');

figure

set(gca, 'FontSize', 16)

plot(W./pi,angle(FR));

ylabel('PHASE IN RADIANS');

xlabel('NORMALISED FREQUENCY');

[IR,t]=impz(numz,denz);

figure

set(gca, 'FontSize', 16)

plot(t/pi,IR);

title('IMPULSE RESPONSE');

OUTPUT:

DIGITAL BAND STOP FILTER SPECIFICATIONS

ENTER THE VALUE FOR wL(hz) 200

ENTER THE VALUE FOR w1(hz) 250

ENTER THE VALUE FOR w2(hz) 300

ENTER THE VALUE FOR wU(hz) 350

ENTER THE SAMPLING FREQUENCY 1000

Enter the passband attenuation(db) 2

Enter the stopband attenuation(db) 20

The order of the filter is 3

THE POLES ARE -0.5000 + 0.8660i -1.0000 + 0.0000i -0.5000 - 0.8660i





RESULT:

Thus,IIR filters have been designed for the desired specifications using Matlab.