**Lab4.m**

% lab Exercise 1

% Q1

%%%%%%%%%%%%%%%%%%%%%%%% Butterfly

Wp =10;

Ws =20;

Pb = 0.9; %Passband

Sb = 0.15; %Stopband

Rp = -20\*log10(Pb);

Rs = -20\*log10(Sb);

[N,Wc]= buttord(Wp,Ws,Rp,Rs, 's')

[num,den]=butter(N,Wc,'s')

Ht=tf(num,den)

[H,w]=freqs(num,den);

% plot magnitude response

plot(w, abs(H));

xline(Wp,'--k',sprintf('Wp=%0.2f', Wp))

xline(Ws,'--k',sprintf('Ws=%0.2f', Ws))

yline(Pb,'--k',sprintf('delta\_p=%0.2f', Pb))

yline(Sb,'--k',sprintf('delta\_s=%0.2f', Sb))

xlabel('Frequency-w');

ylabel('Magnitude (dB)');

title('Magnitude Repsonse (dB)');

% Bode plot

bode(Ht);

%%%%%%%%%%%%%%%%%%%%%%%% Type II Chebyshev

Wp =10;

Ws =20;

Pb = 0.9; %Passband

Sb = 0.15; %Stopband

Rp = -20\*log10(Pb);

Rs = -20\*log10(Sb);

[N,Wn]= cheb2ord(Wp,Ws,Rp,Rs, 's')

[num,den]=cheby2(N,Rs,Wn,'s')

Ht=tf(num,den)

[H,w]=freqs(num,den);

% plot magnitude response

plot(w, abs(H));

xlabel('Frequency-w');

ylabel('Magnitude (dB)');

title('Magnitude Repsonse (dB)');

xline(Wp,'--k',sprintf('Wp=%0.2f', Wp))

xline(Ws,'--k',sprintf('Ws=%0.2f', Ws))

yline(Pb,'--k',sprintf('delta\_p=%0.2f', Pb))

yline(Sb,'--k',sprintf('delta\_s=%0.2f', Sb))

% Bode plot

bode(Ht);

% compare plot

Wp =10;

Ws =20;

Pb = 0.9; %Passband

Sb = 0.15; %Stopband

Rp = -20\*log10(Pb);

Rs = -20\*log10(Sb);

[N,Wc]= buttord(Wp,Ws,Rp,Rs, 's')

[num,den]=butter(N,Wc,'s')

Ht=tf(num,den)

[H,w]=freqs(num,den);

subplot(2,1,1); % 2 rows, 1 column, 1st spot

% plot magnitude response

plot(w, abs(H));

xlabel('Frequency-w');

ylabel('Magnitude (dB)');

title('Magnitude Repsonse (dB) using Butterworth');

[N,Wn]= cheb2ord(Wp,Ws,Rp,Rs, 's')

[num,den]=cheby2(N,Rs,Wn,'s')

Ht=tf(num,den)

[H,w]=freqs(num,den);

subplot(2,1,2); % 2 rows, 1 column, 1st spot

% plot magnitude response

plot(w, abs(H));

xlabel('Frequency-w');

ylabel('Magnitude (dB)');

title('Magnitude Repsonse (dB) using Type II Chebyshev');

%--------------------------- Q2------------------------------

% Type I Chebyshev

Wp =15;

Ws =20;

Pb = 0.9; %Passband

Sb = 0.15; %Stopband

Rp = -20\*log10(Pb);

Rs = -20\*log10(Sb);

[N,Wn]= cheb1ord(Wp,Ws,Rp,Rs, 's');

[num,den]=cheby1(N,Rp,Wn,'s');

Ht=tf(num,den)

[H,w]=freqs(num,den);

% plot magnitude response

plot(w, abs(H));

xlabel('Frequency-w');

ylabel('Magnitude (dB)');

title('Magnitude Repsonse (dB)');

xline(Wp,'--k',sprintf('Wp=%0.2f', Wp))

xline(Ws,'--k',sprintf('Ws=%0.2f', Ws))

yline(Pb,'--k',sprintf('delta\_p=%0.2f', Pb))

yline(Sb,'--k',sprintf('delta\_s=%0.2f', Sb))

% Bode plot

bode(Ht);

%%%% Elliptic

Wp =15;

Ws =20;

Pb = 0.9; %Passband

Sb = 0.15; %Stopband

Rp = -20\*log10(Pb);

Rs = -20\*log10(Sb);

[N,Wn]= ellipord(Wp,Ws,Rp,Rs, 's')

[num,den]=ellip(N,Rp,Rs,Wn,'s')

Ht=tf(num,den)

[H,w]=freqs(num,den);

% plot magnitude response

plot(w, abs(H));

xlabel('Frequency-w');

ylabel('Magnitude (dB)');

title('Magnitude Repsonse (dB)');

xline(Wp,'--k',sprintf('Wp=%0.2f', Wp))

xline(Ws,'--k',sprintf('Ws=%0.2f', Ws))

yline(Pb,'--k',sprintf('delta\_p=%0.2f', Pb))

yline(Sb,'--k',sprintf('delta\_s=%0.2f', Sb))

% Bode plot

bode(Ht);

% compare plot

Wp =15;

Ws =20;

Pb = 0.9; %Passband

Sb = 0.15; %Stopband

Rp = -20\*log10(Pb);

Rs = -20\*log10(Sb);

[N,Wn]= cheb1ord(Wp,Ws,Rp,Rs, 's');

[num,den]=cheby1(N,Rp,Wn,'s');

Ht=tf(num,den)

[H,w]=freqs(num,den);

subplot(2,1,1); % 2 rows, 1 column, 1st spot

% plot magnitude response

plot(w, abs(H));

xlabel('Frequency-w');

ylabel('Magnitude (dB)');

title('Magnitude Repsonse (dB) using Type I Chebyshev');

[N,Wn]= ellipord(Wp,Ws,Rp,Rs, 's')

[num,den]=ellip(N,Rp,Rs,Wn,'s')

Ht=tf(num,den)

[H,w]=freqs(num,den);

subplot(2,1,2); % 2 rows, 1 column, 1st spot

% plot magnitude response

plot(w, abs(H));

xlabel('Frequency-w');

ylabel('Magnitude (dB)');

title('Magnitude Repsonse (dB) using Elliptic');

% Exercise 2

% Elliptic filter

% high pass

wp=1; ws=0.1; Rp=-20\*log(0.9); Rs=20;

[N,Hwn] = ellipord(wp,ws,Rp,Rs,'s') ;

[num4,den4] = ellip(N,Rp,Rs,Hwn,'high','s') ;

H4 = tf(num4,den4);

[H,w]=freqs(num4,den4);

% subplot(3,1,1); % 3 rows, 1 column, 1st spot

plot(w, abs(H));

xlabel('Frequency-w');

ylabel('Magnitude (dB)');

title('High pass');

% low pass

wp=10; ws=60; Rp=-20\*log(0.9); Rs=40;

[N,Lwn] = ellipord(wp,ws,Rp,Rs,'s') ;

[num4,den4] = ellip(N,Rp,Rs,Lwn,'s') ;

H4 = tf(num4,den4);

[H,w]=freqs(num4,den4);

% subplot(3,1,2); % 3 rows, 1 column, 2nd spot

plot(w, abs(H));

xlabel('Frequency-w');

ylabel('Magnitude (dB)');

title('Low pass');

[num,den] = ellip(N,Rp,Rs,[Hwn Lwn],'s') ;

H = tf(num,den);

[PH,w]=freqs(num,den);

% subplot(3,1,3); % 3 rows, 1 column, 3rd spot

plot(w, abs(PH));

xlabel('Frequency-w');

ylabel('Magnitude (dB)');

title('Band pass');

xline(1,'--k','Wp1=1')

xline(10,'--k','Wp2=10')

xline(0.1,'--k','Ws1=0.1')

xline(60,'--k','Ws2=60')

yline(0.9,'--k','Pb=0.9')

yline(0.1,'--k','Sb1=0.1')

yline(0.01,'--k','Sb2=0.01')

%%%%% %butterworth

% high pass

wp=1; ws=0.1; Rp=-20\*log(0.9); Rs=20;

[N, Hwc] = buttord(wp,ws,Rp,Rs,'s');

[num1,den1] = butter(N,Hwc,'high','s');

H4 = tf(num1,den1);

[H,w]=freqs(num1,den1);

% subplot(3,1,1); % 3 rows, 1 column, 1st spot

plot(w, abs(H));

xlabel('Frequency-w');

ylabel('Magnitude (dB)');

title('High pass');

% low pass

wp=10; ws=60; Rp=-20\*log(0.9); Rs=40;

[N, Lwc] = buttord(wp,ws,Rp,Rs,'s');

[num1,den1] = butter(N,Lwc,'s');

H4 = tf(num1,den1);

[H,w]=freqs(num1,den1);

% subplot(3,1,2); % 3 rows, 1 column, 2nd spot

plot(w, abs(H));

xlabel('Frequency-w');

ylabel('Magnitude (dB)');

title('Low pass');

[num,den] = butter(N,[Hwc Lwc],'s') ;

H = tf(num,den);

[PH,w]=freqs(num,den);

% subplot(3,1,3); % 3 rows, 1 column, 3rd spot

plot(w, abs(PH));

xlabel('Frequency-w');

ylabel('Magnitude (dB)');

title('Band pass');

xline(1,'--k','Wp1=1')

xline(10,'--k','Wp2=10')

xline(0.1,'--k','Ws1=0.1')

xline(60,'--k','Ws2=60')

yline(0.9,'--k','Pb=0.9')

yline(0.1,'--k','Sb1=0.1')

yline(0.01,'--k','Sb2=0.01')

% bode

bode(H);

% tried

wp=[1 10]; ws=[0.1 60]; Rp=-20\*log(0.9);Rs=40;

[N,wn] = ellipord(wp,ws,Rp,Rs,'s');

[num4,den4] = ellip(N,Rp,Rs,wn,'s');

H4 = tf(num4,den4);

[PH,w]=freqs(num,den);

plot(w, abs(PH));

yline(0.1,'--k','Sb1=0.1')

yline(0.01,'--k','Sb2=0.01')