

Butterworth Low-Pass Filter Design and Frequency Response

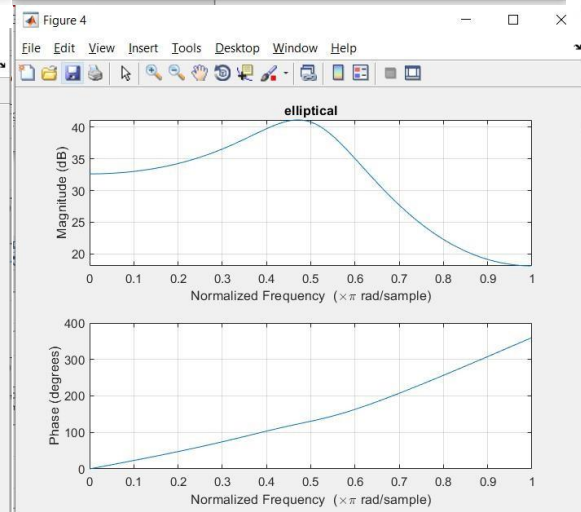
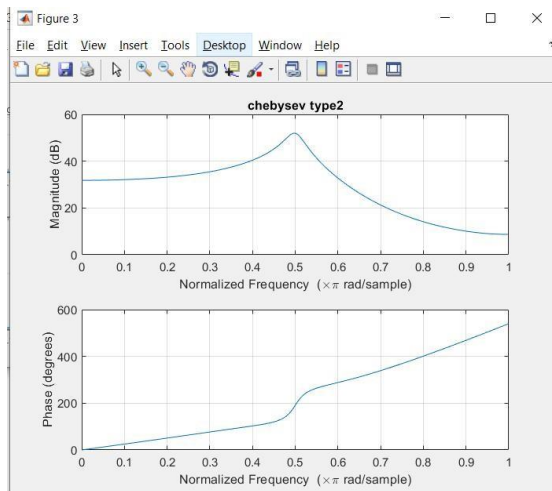
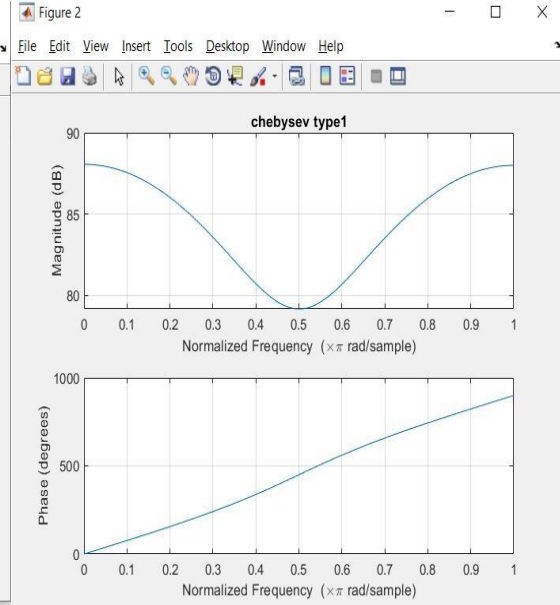
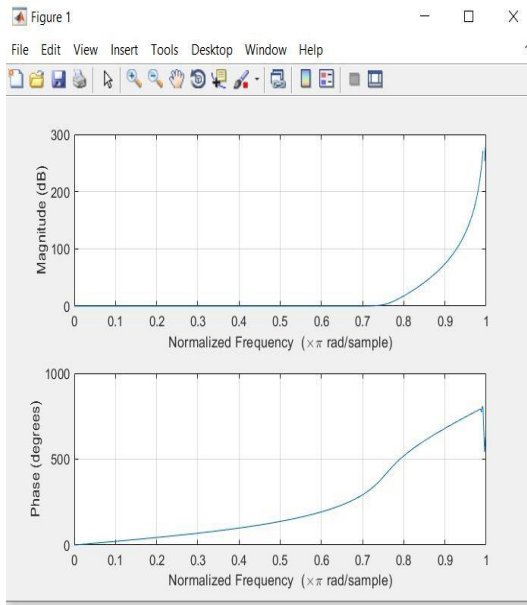
```
2.clc;
3.clear all;
4.close all;
5.fp=4; %pass band freq
6.fs=8; %stop band frequency
7.Fs=40; %sampling freq
8.kp= 0.5; %passband ripple
9.ks=40; %minimum stopband attenuation
10.    wp= 2*pi*(fp/Fs); %normalized
11.    ws= 2*pi*(fs/Fs);
12.    [N,Wc]=buttord(wp ,ws ,kp ,ks,'s');
13.    [b,a]=butter(N,Wc,'low');
14.    disp('denominator');
15.    disp(b);
16.    disp('numerator');
17.    disp(a);
18.    title('butterworth');
19.    figure(1);
20.    freqz(a,b);
21.    [M,Cc]=cheb1ord(wp,ws,kp,ks,'s' );
22.    [bb,aa]=cheby1 (M,ks,wp,'s');
23.    disp('denominator of chebysev type 1');
24.    disp(bb);
25.    disp('numerator of chebysev type 2');
26.    disp(aa);
27.    figure(2);
28.    freqz(aa,bb); 29.    title('chebysev type1')
30.
31.    [O,pc]=cheb2ord(wp,ws,kp,ks,'s' );
32.    [bbb,aaa]=cheby2 (O,ks,wp,'low','s');
33.    disp('denominator of chebysev type 1');
34.    disp(bbb);
35.    disp('numerator of chebysev type 2');
36.    disp(aaa);
37.    figure(3);
38.    freqz(aaa,bbb); 39.    title('chebysev
type2')
40.
41.    [P,pc]=ellipord(wp,ws,kp,ks,'s' );
42.    [bbbb,aaaa]=cheby2 (P,ks,wp,'low','s');
```

```

43.     disp('denominator of elliptical');
44.     disp(bbbb);
45.     disp('numerator of elliptical');
46.     disp(aaaa);
47.     figure(4);
48.     freqz(aaaa,bbbb);
49.     title('elliptical')

```





Chebyshev Type I and Type II Stop-Band Filter Design

```
1.ws=[2.1,4.5];
2.wp=[2.7,3.9];
3.kp=0.6;
4.ks=12;
5.[N,Wc]=buttord(wp,ws,kp,ks,'s');
6.[b,a]=butter(N,Wc,'stop','s');
7.disp('denominator');
8.disp(b);
9.disp('numerator');
10.    disp(a);
11.    title('butterworth');
12.    figure(1);
13.    freqz(a,b);
14.    [M,Cc]=cheblord(wp,ws,kp,ks,'s');
15.    [bb,aa]=cheby1(M,ks,wp,'s');
16.    disp('denominator of chebysev type 1');
17.    disp(bb);
18.    disp('numerator of chebysev type 2');
19.    disp(aa);
20.    figure(2);
21.    freqz(aa,bb);
22.    title('chebysev type1')
23.    [O,pc]=cheb2ord(wp,ws,kp,ks,'s');
24.    [bbb,aaa]=cheby2(O,ks,wp,'stop','s');
25.    disp('denominator of chebysev type 1');
26.    disp(bbb);
27.    disp('numerator of chebysev type 2');
28.    disp(aaa);
29.    figure(3);
30.    freqz(aaa,bbb);
31.    title('chebysev type2')
32.    [P,pc]=ellipord(wp,ws,kp,ks,'s');
33.    [bbbb,aaaa]=cheby2(P,ks,wp,'stop','s');
34.    disp('denominator of elliptical');
35.    disp(bbbb);
36.    disp('numerator of elliptical');disp(aaaa);
37.    figure(4);
38.    freqz(aaaa,bbbb);
39.    title('elliptical');
```

MATLAB R2018a

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C:\Program Files\MATLAB\R2018a\bin

Command Window

```
>> labex2
denominator
1.0e+04 *
    0.0001         0    0.0042         0    0.0665         0    0.4670         0    1.2295

numerator
1.0e+04 *
    0.0001    0.0004    0.0050    0.0137    0.0842    0.1441    0.5570    0.4704    1.2295

denominator of chebysev type 1
         0         0         0    0.1121         0         0         0

numerator of chebysev type 2
1.0e+03 *
    0.0010    0.0002    0.0327    0.0044    0.3442    0.0228    1.1676

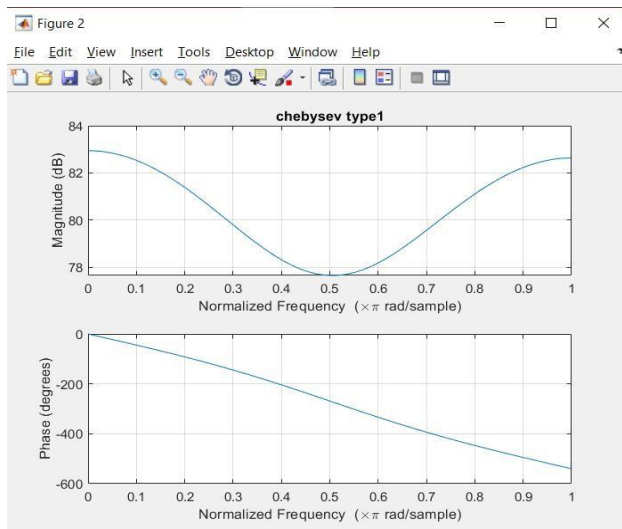
denominator of chebysev type 1
1.0e+03 *
    0.0010   -0.0000    0.0327   -0.0000    0.3440   -0.0000    1.1676

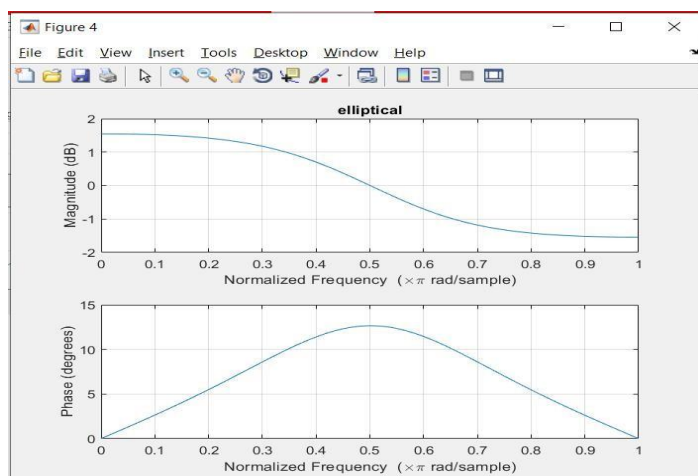
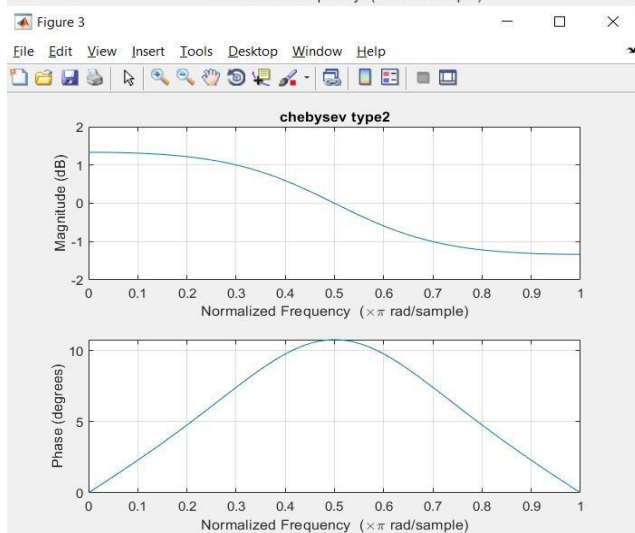
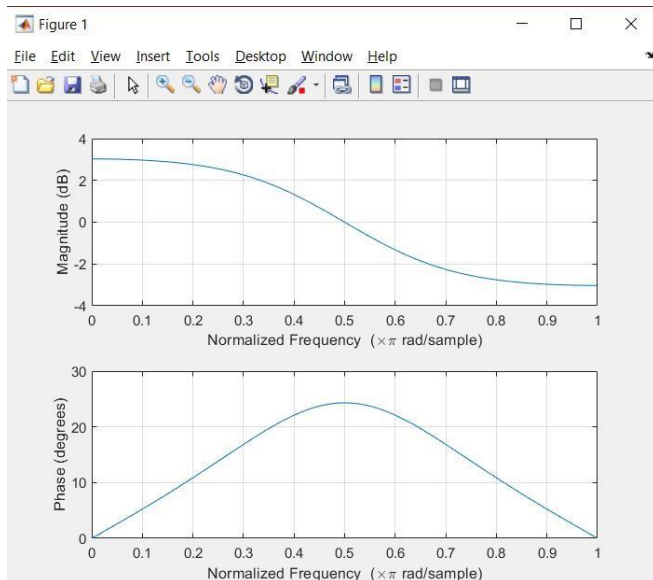
numerator of chebysev type 2
1.0e+03 *
    0.0010    0.0018    0.0343    0.0391    0.3607    0.1973    1.1676

denominator of elliptical
    1.0000   -0.0000    21.7800   -0.0000   110.8809

numerator of elliptical
    1.0000    2.0719    23.9264    21.8170   110.8809

fx >>
```





User-Input Based Butterworth Low-Pass Filter Design

```
1.pb=input('enter the maximum pass band filter attenuation in
db' );
2.sp=input('enter the maximum stop band filter attenuation in
db' );
3.wp=input('enter the analog pass band cutoff freq in hz' );
4.ws=input('enter the analog stop band cutoff freq in hz' );
5.fs=input('enter the sampling freq in hz');
6.Wp=2*pi*wp;
7.Ws=2*pi*ws;
8.[N,Wc]=buttord(Wp,Ws,pb,sp,'s')
9.[b,a]=butter(N,Wc,'low','s')
10.    [bz,az]=impinvar(b,a,fs);
11.    disp('denominator coeff are'); disp(bz);
12.    disp('numerator coeff are'); disp(az); figure(1);
13.    zplane(bz,az); figure(2);
14.    freqz(bz,az);
```

Command Window

```
>> labex3
enter the maximum pass band filter attenuation in db2
enter the maximum stop band filter attenuation in db20
enter the analog pass band cutoff freq in hz500
enter the analog stop band cutoff freq in hz2000
enter the sampling freq in hz10000

N =

    2

Wc =

    3.9838e+03

b =

    1.0e+07 *

         0         0    1.5871

a =

    1.0e+07 *

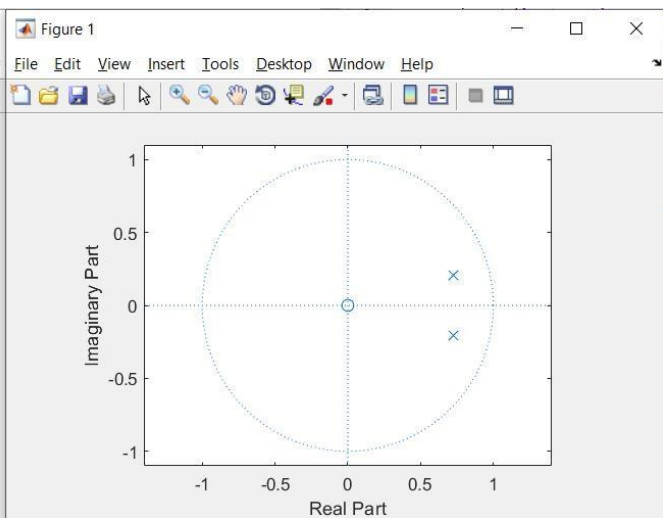
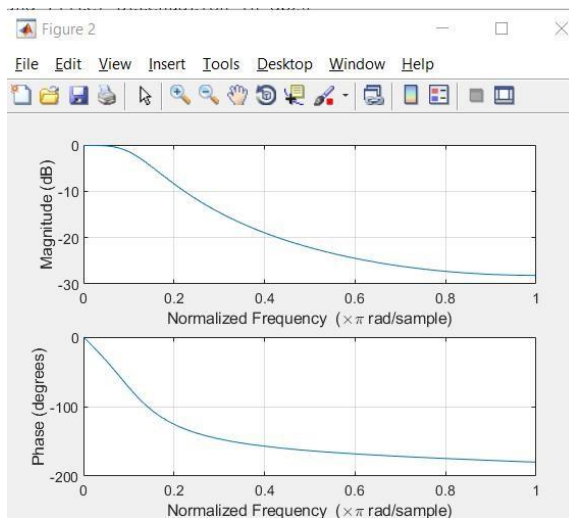
    0.0000    0.0006    1.5871

denominator coeff are

         0    0.1182         0

numerator coeff are

    1.0000   -1.4495    0.5693
```



Chebyshev Type II Low-Pass Filter with Frequency Response Analysis

```
pb=input('enter the maximum pass band filter attenuation in db' );
sp=input('enter the maximum stop band filter attenuation in db' );
wp=input('enter the analog pass band cutoff freq in hz' );
ws=input('enter the analog stop band cutoff freq in hz' );
fs=input('enter the sampling freq in hz');
ks=input('enter the minimum stopband attenuation');
Wp=2*pi*wp;
Ws=2*pi*ws;
[N,Wc]=cheb2ord(Wp,Ws,pb,sp,'s');
[b,a]=cheby2(N,ks,wp,'low','s');
disp('denominator of chebysev type 2');
disp(b);
disp('numerator of chebysev type 2');
disp(a);
figure(3);
freqz(a,b);
title('chebysev type2')

[bz,az]=bilinear(a,b,fs);
disp('numerator coeff are');
disp(az);
disp('denum coeff are');
disp(bz);
figure(1);
zplane(az,bz);
figure(2);
freqz(bz,az);

>> labex4
enter the maximum pass band filter attenuation in db2
enter the maximum stop band filter attenuation in db20
enter the analog pass band cutoff freq in hz500
enter the analog stop band cutoff freq in hz2000
enter the sampling freq in hz10000
enter the minimum stopband attenuation0.5
denominator of chebysev type 2
1.0e+05 *

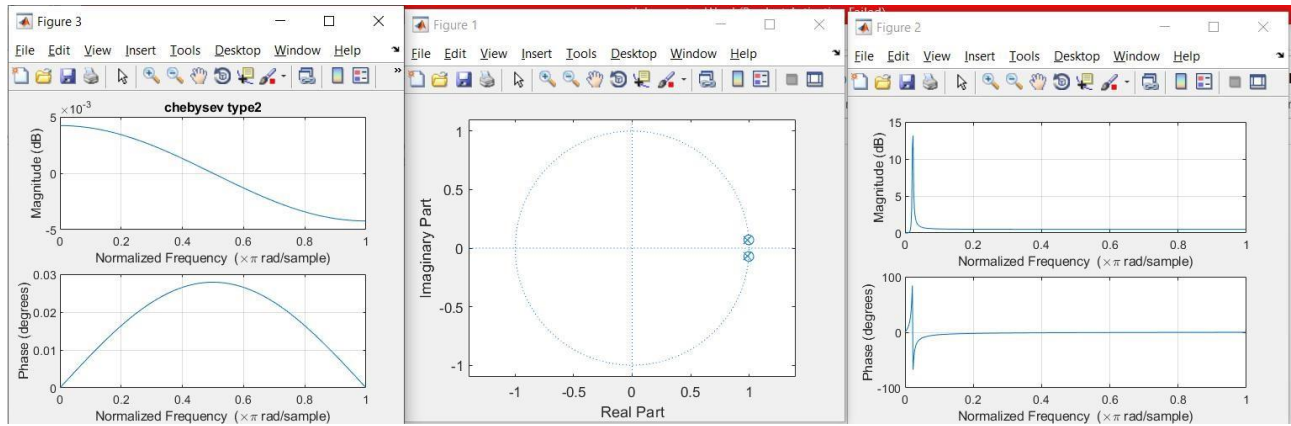
0.0000    0.0000    4.7203

numerator of chebysev type 2
1.0e+05 *

0.0000    0.0023    4.7203

numerator coeff are
1.0000   -1.9950    1.0000

denum coeff are
1.0713   -2.1134    1.0470
```



Bilinear Transformation and Frequency Analysis of Chebyshev Type II Filter

```

pb=input('enter the maximum pass band filter attenuation in db' );
sp=input('enter the maximum stop band filter attenuation in db' );
wp=input('enter the analog pass band cutoff freq in hz' );
ws=input('enter the analog stop band cutoff freq in hz' );
fs=input('enter the sampling freq in hz');
ks=input('enter the minimum stopband attenuation');
Wp=2*pi*wp;
Ws=2*pi*ws;
[N,Wc]=cheb2ord(Wp,Ws,pb,sp,'s');
[b,a]=cheby2(N,ks,wp,'low','s');
disp('denominator of chebysev type 2');
disp(b);
disp('numerator of chebysev type 2');
disp(a);
figure(3);
freqz(a,b);
title('chebysev type2');
[bz,az]=bilinear(a,b,fs);
disp('numerator coeff are');
disp(az);
disp('denum coeff are');
disp(bz);
figure(1);
zplane(bz,az);
figure(2);
q=freqz(bz,az);
figure(5);
plot(angle(q));
figure(4);
plot(abs(q));

```

```

>> lab8ex5
enter the maximum pass band filter attenuation in db2
enter the maximum stop band filter attenuation in db20
enter the analog pass band cutoff freq in hz500
enter the analog stop band cutoff freq in hz2000
enter the sampling freq in hz10000
enter the minimum stopband attenuation0.5
denominator of chebysev type 2
    1.0e+05 *

    0.0000    0.0000    4.7203

numerator of chebysev type 2
    1.0e+05 *

    0.0000    0.0023    4.7203

numerator coeff are
    1.0000   -1.9950    1.0000

denum coeff are
    1.0713   -2.1134    1.0470

```

