6.3 设计Butterworth滤波器和Chebyshev滤波器

6.3（1）利用双线性z变换法设计Butterworth数字高通滤波器：

```
clear all;
close all;
fp=400;
fs=300;
Fs=1000;
Rp=3;  Rs=35;

wp=2*pi*fp/Fs;
ws=2*pi*fs/Fs;

OmegaP=2*Fs*tan(wp/2);
OmegaS=2*Fs*tan(ws/2);

[N,Wn]=buttord(OmegaP,OmegaS,Rp,Rs,'s');  %选择模拟巴特沃斯低通滤波器的最小阶数
[z,p,k]=buttap(N);            %创建巴特沃斯模拟低通滤波器
[Bp,Ap]=zp2tf(z,p,k)          %由零点、极点、增益确定传输函数的分子与分母的系数
```

```
Bp = 1×7
     0     0     0     0     0     0     1
Ap = 1×7
    1.0000    3.8637    7.4641    9.1416    7.4641    3.8637    1.0000
```

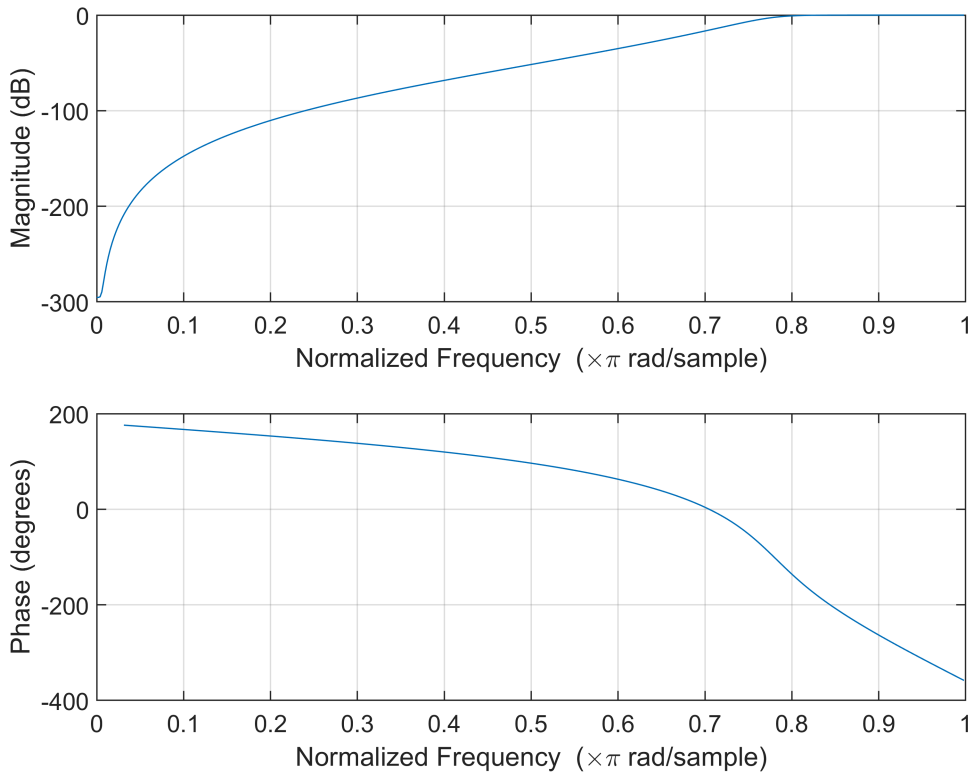
```
[b,a]=lp2hp(Bp,Ap,Wn)         %模拟低通滤波器到模拟高通滤波器的转换
```

```
b = 1×7
10^6 ×
    0.0000    0.0000    0.0000    0.0000    0.0000    0.0031    4.1297
a = 1×7
10^22 ×
    0.0000    0.0000    0.0000    0.0000    0.0000    0.0018    2.4465
```

```
[bz,az]=bilinear(b,a,Fs)
```

```
bz = 1×7
    0.0006   -0.0038    0.0096   -0.0128    0.0096   -0.0038    0.0006
az = 1×7
    1.0000    3.2634    4.8207    3.9984    1.9417    0.5193    0.0594
```

```
figure(1);
freqz(bz,az);
```



6.3（2）利用双线性**z**变换法设计**Chebychev**数字带通滤波器：

```
%--------------------------------------------------------------------------
% exa060603.m, for example 6.6.3;
% To design IIR Butteworth bandstop DF by analog-lowpass,
% -------------------------------------------------------------------------
clear all;

fp=[300 400];fs=[200 500];
%wp=[.19*pi 0.21*pi];ws=[.198*pi 0.202*pi];
Fs=2000;
rp=3;rs=40;
wp=fp*2*pi/Fs;ws=fs*2*pi/Fs;
%
% Firstly to finish frequency prewarping;
wap=2*Fs*tan(wp./2)
```

```
wap = 1×2
10^3 ×
    2.0381    2.9062
```

```
was=2*Fs*tan(ws./2);
[n,wn]=cheb1ord(wap,was,rp,rs,'s');
% Note: 's'!
[z,p,k]=cheb1ap(n,rp);
```

```
[b,a]=zp2tf(z,p,k)
```

```
b = 1×5
         0         0         0         0    0.1253
a = 1×5
    1.0000    0.5816    1.1691    0.4048    0.1770
```

```
bw=wap(2)-wap(1)
```

```
bw = 868.0683
```

```
w0=sqrt(wap(1)*wap(2))
```

```
w0 = 2.4337e+03
```

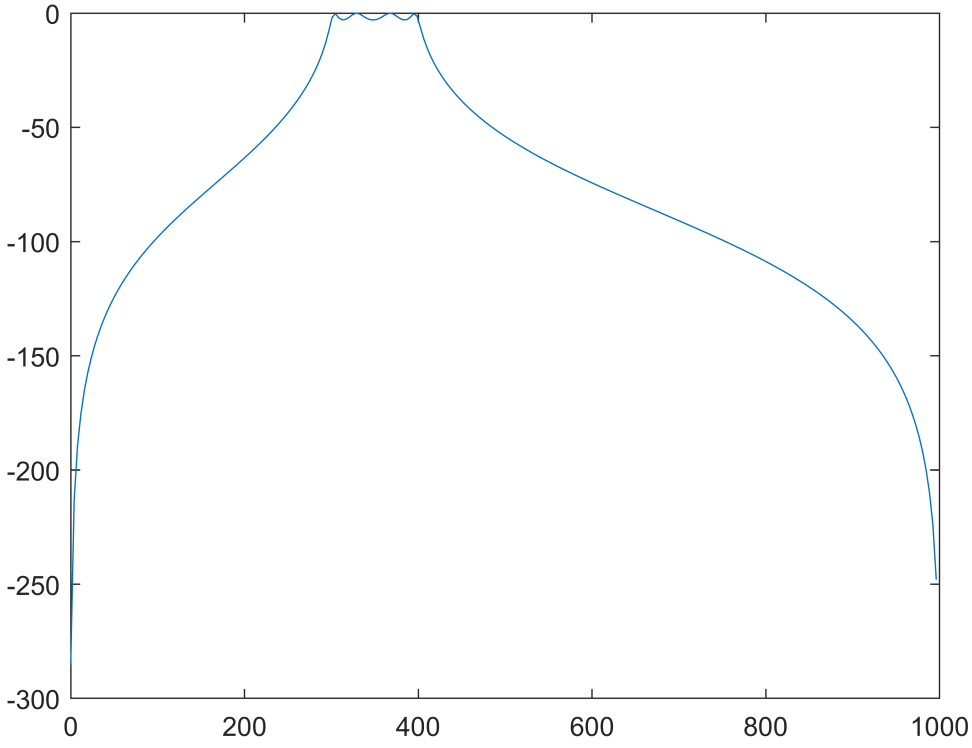
```
[bt,at]=lp2bp(b,a,w0,bw)
```

```
bt = 1×5
10^10 ×
    7.1147   -0.0000   -0.0000         0         0
at = 1×9
10^27 ×
    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0001 ···
```

```
%
% Note: z=(2/ts)(z-1)/(z+1);
[bz1,az1]=bilinear(bt,at,Fs)
```

```
bz1 = 1×9
10^-3 ×
    0.0702   -0.0000   -0.2808   -0.0000    0.4212   -0.0000   -0.2808   -0.0000 ···
az1 = 1×9
    1.0000   -3.5495    8.4668  -12.8267   14.9115  -12.2548    7.7286   -3.0945 ···
```

```
[h,w]=freqz(bz1,az1,256,Fs);
figure(1)
plot(w,20*log10(abs(h)))
```


0
-50
-100
-150
-200
-250
-300
0
200
400
600
800
1000