

9.4: Does your results in parts (a) and (c) match? If not, why not?

The results did not match due to aliasing

```
1  %Part B
2  x = [1 -1 0 2 1 0 0 3];
3  h = [ 1 1 2 1 -1];
4
5  %Part C
6  N=8;
7  X = fft(x,N);
8  H = fft(h,N);
9  Y=X.*H;
10 y = ifft(Y,N);
11 n = 0:7;
12 figure(1)
13
14 stem(n,y);
15 xlabel('samples[n]')
16 ylabel('y[n]= x[n]*h[n]')
17 title('Convolution y[n] = x[n]*h[n] | N = 8')
18 grid
19
20 if FINALPLOTS
21     print -deps PS9-4-1.eps
22 end
23
24 %part D
25 %its does not match due to aliasing
26
27 %part E
28 N=32;
29 X = fft(x,N);
30 H = fft(h,N);
31 Y=X.*H;
32 y = ifft(Y,N);
33 n = 0:31;
34
35 figure(2)
36 stem(n,y);
37 xlabel('samples[n]')
38 ylabel('y[n]= x[n]*h[n]')
39 title('Convolution y[n] = x[n]*h[n] | N = 32')
40 grid
41
42 if FINALPLOTS
43     print -deps PS9-4-2.eps
44 end
```

Code 1: matlab script for Problem 4

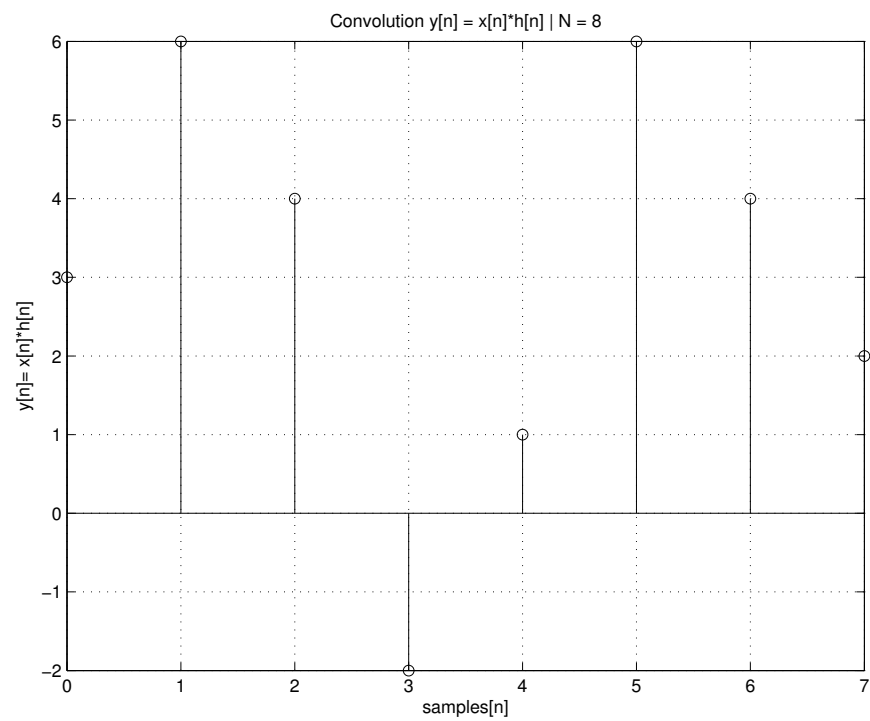


Figure 9.5-1: 4 Part C

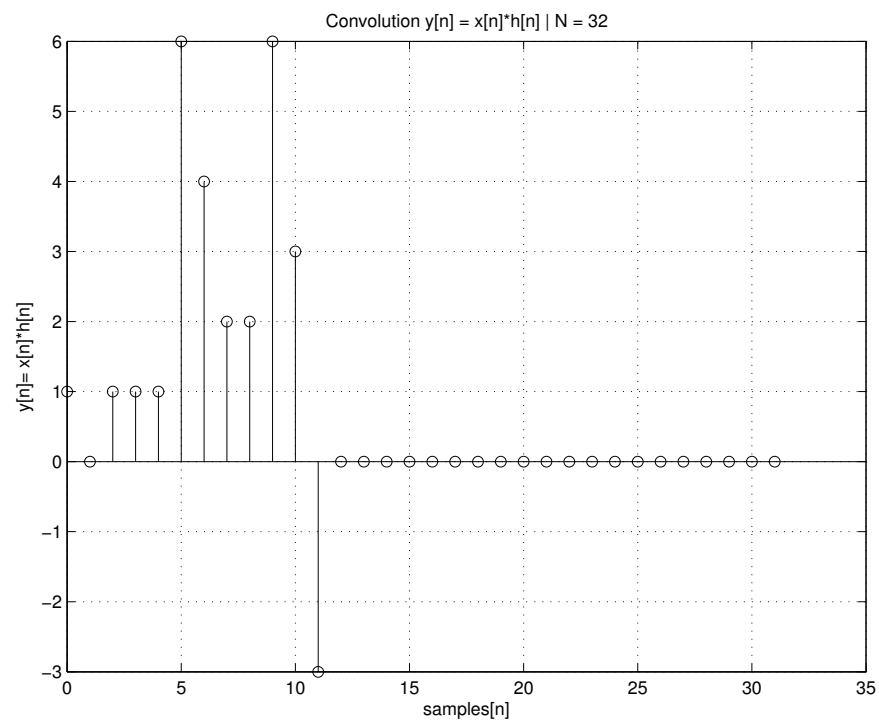


Figure 9.5-2: 4 Part E

A: Which filter needs the highest order? Which is the lowest?

Butterworth N: 11

Chebyshev N: 6

Elliptic N: 4

ButterWorth has the highest order while Elliptic has the Lowest.

C: Can you explain the features of the frequency responses from the poles and zeros?

For the ButterWorth Filter all the zeros correspond to real -1 while all the poles circle around real 1 and in the imaginary domain.

For the Chebyshev Filter the zeros wrapped around the imaginary 1 and -1 while the poles get closer to 0 in both the real and imaginary point.

For the Elliptic Filter the zeros are around the imaginary domain leaning towards the positive real side. The poles around the positive real.

Code: 1

```

1  %Problem 9.5 (b)
2
3  Omegap = 0.2;
4  Omegas = 0.3;
5  d1 = 0.02;
6  d2 = 0.05;
7  Rp = -20*log10(1-d1);
8  Rs = -20*log10(d2);
9
10 %Butterworth:
11 [N_butter, Omegan_butter] = buttord(Omegap, Omegas, Rp, Rs);
12 [bbutter, abutter] = butter(N_butter, Omegan_butter);
13
14 disp('Butterworth N:')
15 disp(N_butter)
16
17 [H_butter Omega_Butter] = freqz(bbutter, abutter, 8192);
18 figure(1)
19 clf
20 subplot(311)
21 plot(Omega_Butter/pi, 20*log10(abs(H_butter)))
22 axis([0 1 -100 0]);
23 xlabel('Frequency (\omega/\pi)')
24 ylabel('|H(e^{j\omega})|')
25 title('Butterworth Filter')
26 grid
27 subplot(312)
28 plot(Omega_Butter/pi, abs(H_butter))
29 axis([0 Omegap 1-d1 1+d1])
30 xlabel('Frequency (\omega/\pi)')
31 ylabel('|H(e^{j\omega})|')
32 title('Butterworth Filter Passband Detail')

```

```

33 subplot(313)
34 plot(Omega_Butter/pi,abs(H_butter))
35 axis([Omegas 1 0 d2])
36 xlabel('Frequency (\omega/\pi)')
37 ylabel('|H(e^{j\omega})|')
38 title('Butterworth Filter Stopband Detail')
39
40
41
42 if FINALPLOTS
43     print -deps PS9-5-1.eps
44 end
45
46
47 %Chebyshev Type II:
48 [N_Chebyshev,Omegan_Chebyshev] = cheb2ord(Omegap,Omegas,Rp,Rs);
49 [bcheby2,acheby2] = cheby2(N_Chebyshev,Rs,Omegan_Chebyshev);
50 [H_Chebyshev,Omega_Chebyshev] = freqz(bcheby2,acheby2,8192);
51
52 disp('Chebyshev N')
53 disp(N_Chebyshev)
54
55 figure(2)
56 clf
57 subplot(311)
58
59 plot(Omega_Chebyshev/pi,20*log10(abs(H_Chebyshev)))
60 xlabel('Frequency (\omega/\pi)')
61 ylabel('|H(e^{j\omega})|')
62 title('Chebyshev Type 2 Filter')
63 axis([0 1 -100 0])
64 grid
65 subplot(312)
66 plot(Omega_Chebyshev/pi,abs(H_Chebyshev))
67 axis([0 Omegap 1-d1 1+d1])
68 xlabel('Frequency (\omega/\pi)')
69 ylabel('|H(e^{j\omega})|')
70 title('Chebyshev Type 2 Filter Passband Detail')
71 subplot(313)
72 plot(Omega_Chebyshev/pi,abs(H_Chebyshev))
73 axis([Omegas 1 0 d2])
74 xlabel('Frequency (\omega/\pi)')
75 ylabel('|H(e^{j\omega})|')
76 title('Chebyshev Type 2 Filter Stopband Detail')
77
78 if FINALPLOTS
79     print -deps PS9-5-2.eps
80 end
81
82
83 %Elliptic filter:
84
85 [N_Elliptic,Omegan_Elliptic] = ellipord(Omegap,Omegas,Rp,Rs);
86 [bElliptic,aElliptic] = ellip(N_Elliptic,Rp,Rs,Omegan_Elliptic);
87 [H_Elliptic,Omega_Elliptic] = freqz(bElliptic,aElliptic,8192);
88
89 disp('Elliptic N')
90 disp(N_Elliptic)
91
92 figure(3)
93 clf
94 subplot(311)

```

```

95 plot(Omega_Elliptic/pi,20*log10(abs(H_Elliptic)))
96 xlabel('Frequency (\omega/\pi)')
97 ylabel('|H(e^{j\omega})|')
98 title('Elliptic Filter')
99 axis([0 1 -100 0])
100 grid
101 subplot(312)
102 plot(Omega_Elliptic/pi,abs(H_Elliptic))
103 axis([0 Omegap 1-d1 1+d1])
104 xlabel('Frequency (\omega/\pi)')
105 ylabel('|H(e^{j\omega})|')
106 title('Elliptic Filter Passband Detail')
107 subplot(313)
108 plot(Omega_Elliptic/pi,abs(H_Elliptic))
109 axis([Omegas 1 0 d2])
110 xlabel('Frequency (\omega/\pi)')
111 ylabel('|H(e^{j\omega})|')
112 title('Elliptic Filter Stopband Detail')
113
114 if FINALPLOTS
115     print -deps PS9-5-3.eps
116 end
117
118 %Part 3
119 %Butterworth
120 figure(4)
121 xlabel('Re(z)')
122 ylabel('Im(z)')
123 title('Dzplot of a ButterWorth Filter')
124 grid
125 dpzplot(bbutter,abutter)
126
127 if FINALPLOTS
128     print -deps PS9-5-4.eps
129 end
130
131 %Chebyshev
132 figure(5)
133 xlabel('Re(z)')
134 ylabel('Im(z)')
135 title('Dzplot of a Chebyshev Filter')
136 grid
137 dpzplot(bcbeby2,acheby2)
138
139 if FINALPLOTS
140     print -deps PS9-5-5.eps
141 end
142
143 %Elliptic
144 figure(6)
145 xlabel('Re(z)')
146 ylabel('Im(z)')
147 title('Dzplot of a Elliptic Filter')
148 grid
149 dpzplot(bElliptic,aElliptic)
150
151 if FINALPLOTS
152     print -deps PS9-5-6.eps
153 end

```

Code 2: matlab script for Problem 5

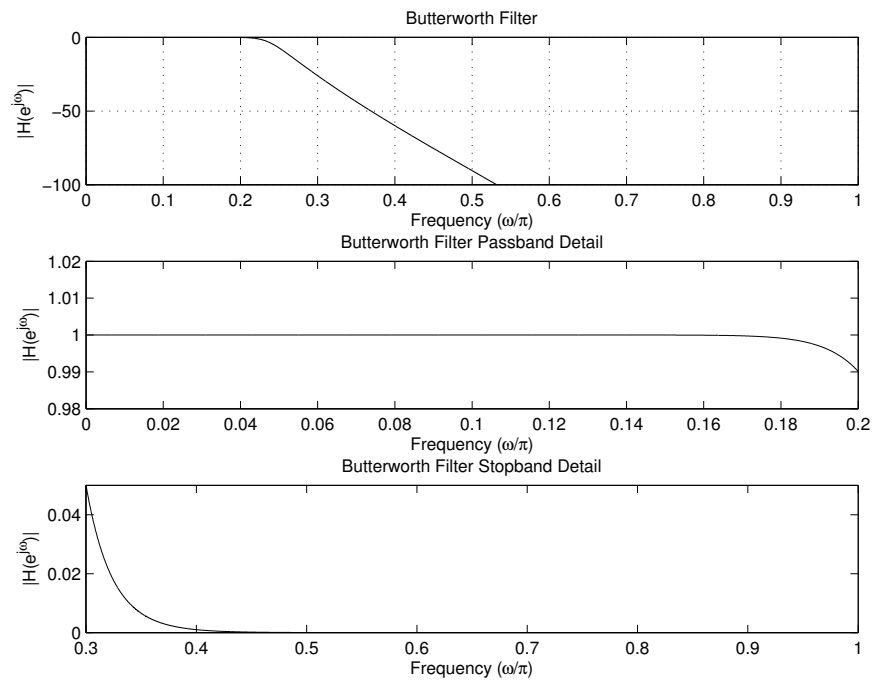


Figure 9.5-3: ButterWorth Filter

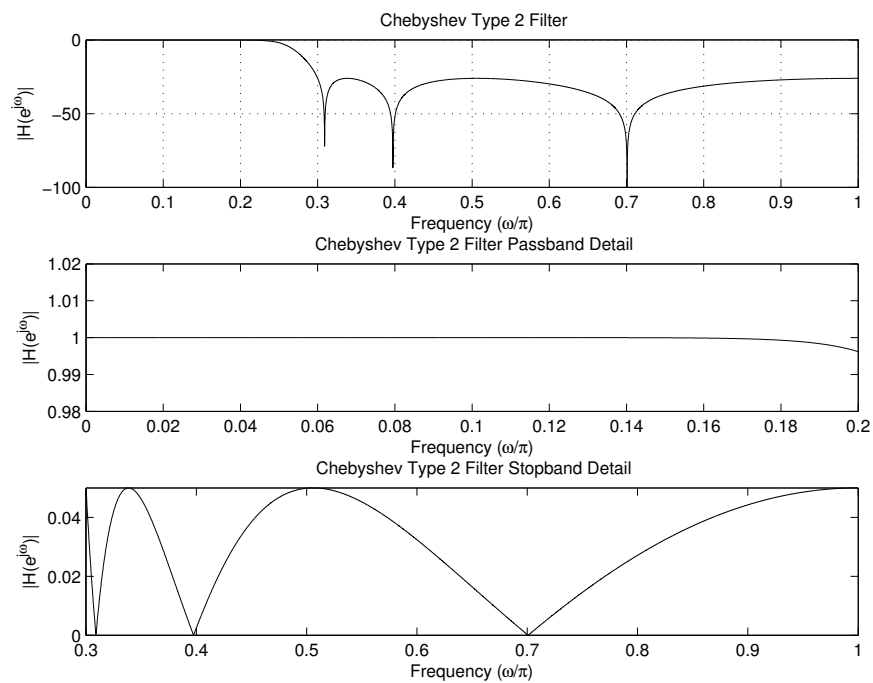


Figure 9.5-4: Chebyshev Filter

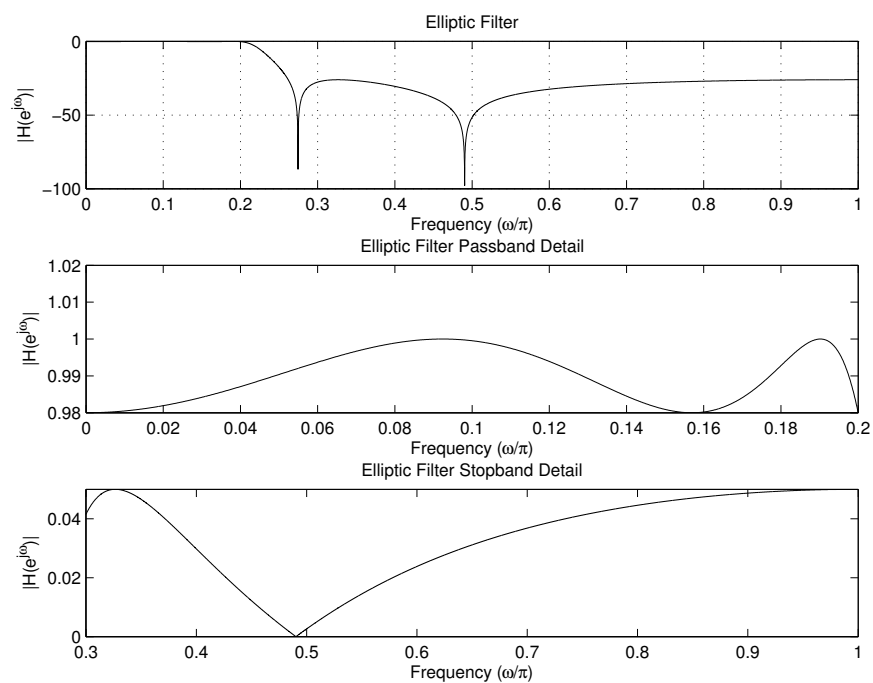


Figure 9.5-5: Elliptic Filter

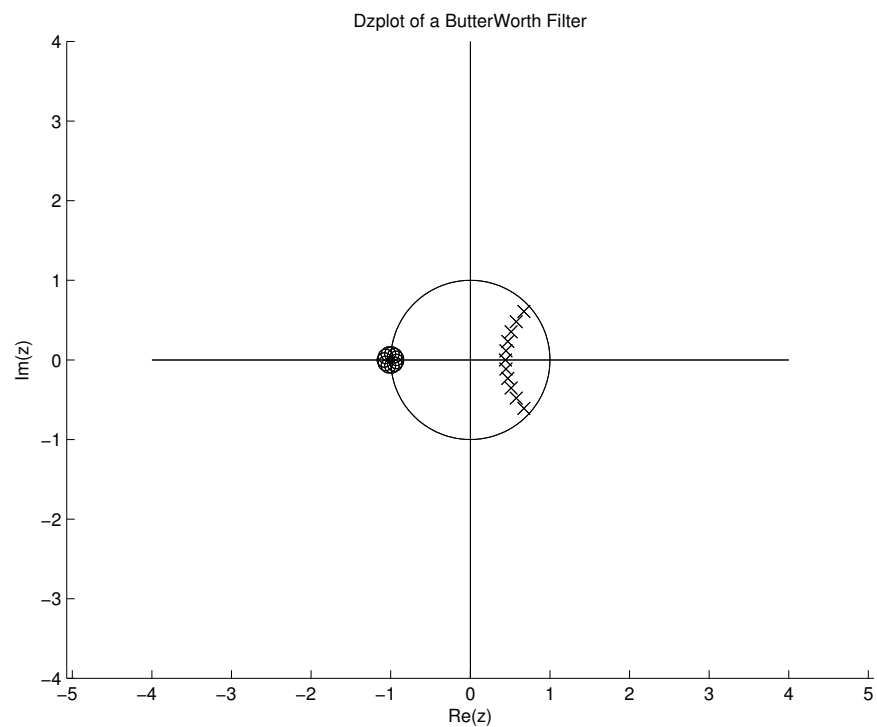


Figure 9.5-6: ButterWorth Zeroplot

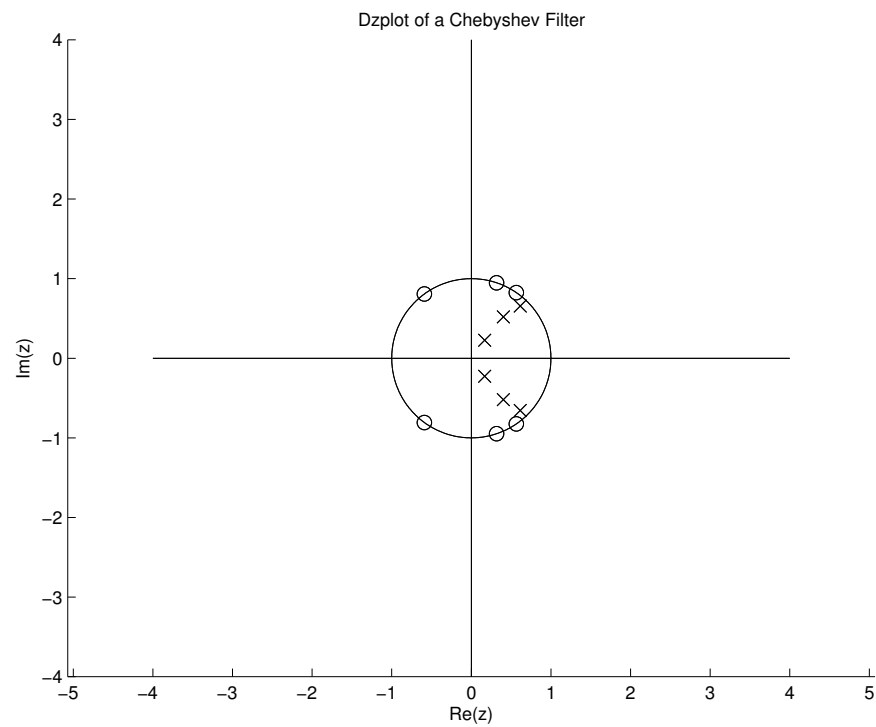


Figure 9.5-7: Chebyshev Zeroplot

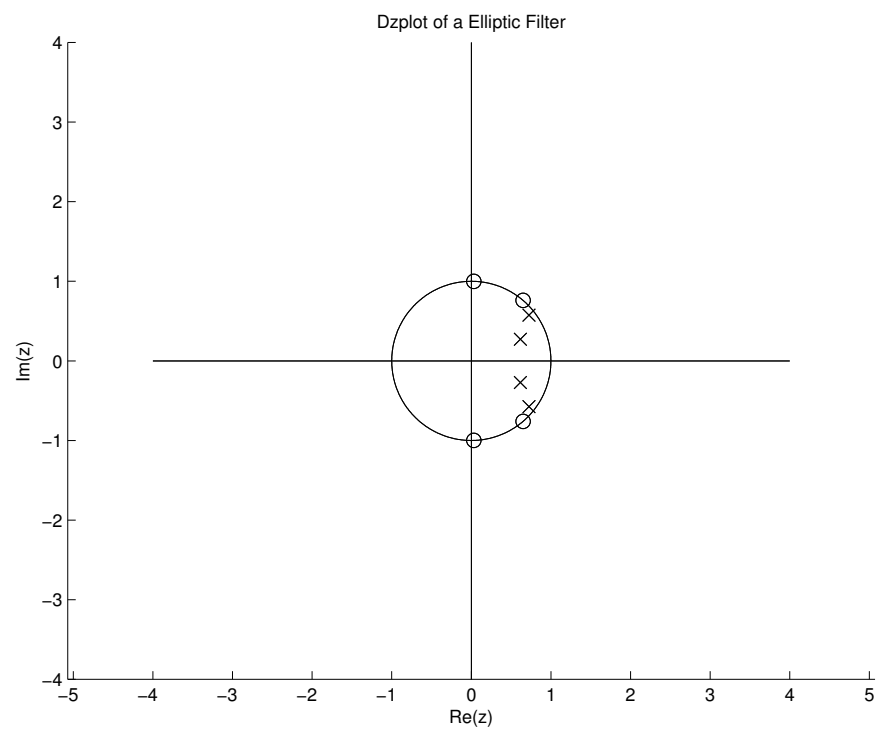


Figure 9.5-8: Elliptic Zeroplot