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

The results did not match due to aliasing

```
%Part B
x = [1 -1 0 2 1 0 0 3];
h = [ 1 1 2 1 -1];

%Part C
N=8;
X = fft(x,N);
H = fft(h,N);
Y=X.*H;
y = ifft(Y,N);
n = 0:7;
figure(1)

stem(n,y);
xlabel('samples[n]')
ylabel('y[n]= x[n]*h[n]')
title('Convolution y[n] = x[n]*h[n] | N = 8')
grid

if FINALPLOTS
    print -deps PS9-4-1.eps
end

%part D
%its does not match due to aliasing

%part E
N=32;
X = fft(x,N);
H = fft(h,N);
Y=X.*H;
y = ifft(Y,N);
n = 0:31;

figure(2)
stem(n,y);
xlabel('samples[n]')
ylabel('y[n]= x[n]*h[n]')
title('Convolution y[n] = x[n]*h[n] | N = 32')
grid

if FINALPLOTS
    print -deps PS9-4-2.eps
end
```

Code 1: matlab script for Problem 4

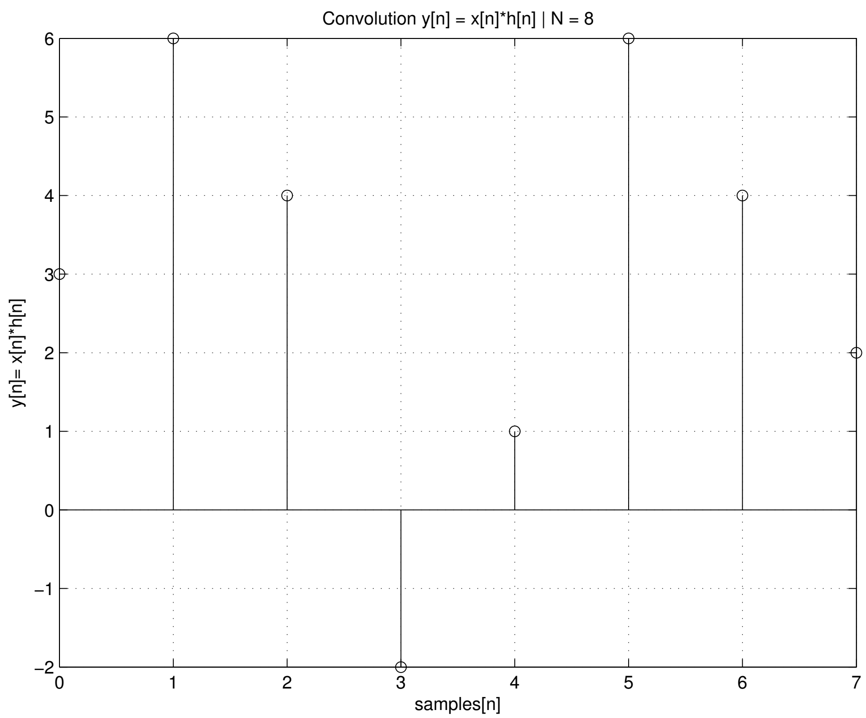

Figure 9.5-1: 4 Part C

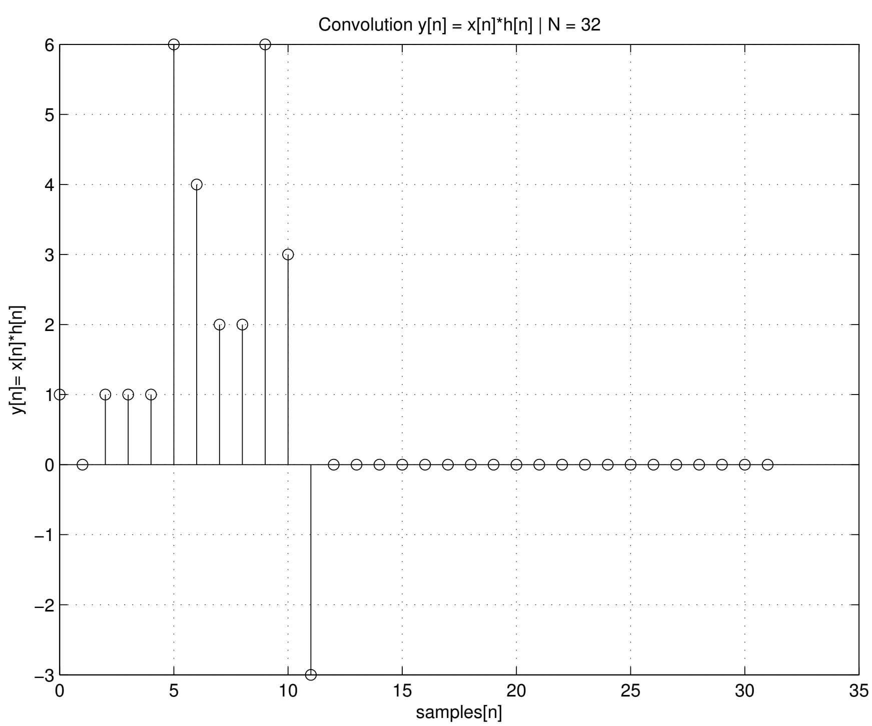

Figure 9.5-2: 4 Part E

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 corespond 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

```
%Problem 9.5 (b)

Omegap = 0.2;
Omegas = 0.3;
d1 = 0.02;
d2 = 0.05;
Rp = -20*log10(1-d1);
Rs = -20*log10(d2);

%Butterworth:
[N_butter,Omegan_butter] = buttord(Omegap,Omegas,Rp,Rs);
[bbutter,abutter] = butter(N_butter,Omegan_butter);

disp('Butterworth N:')
disp(N_butter)

[H_butter Omega_Butter] = freqz(bbutter, abutter, 8192);
figure(1)
clf
subplot(311)
plot(Omega_Butter/pi,20*log10(abs(H_butter)))
axis([0 1 -100 0]);
xlabel('Frequency (\omega/\pi)')
ylabel('|H(e^{j\omega})|')
title('Butterworth Filter')
grid
subplot(312)
plot(Omega_Butter/pi,abs(H_butter))
axis([0 Omegap 1-d1 1+d1])
xlabel('Frequency (\omega/\pi)')
ylabel('|H(e^{j\omega})|')
title('Butterworth Filter Passband Detail')
```

Code: 1 continued on next page...

```
subplot(313)
plot(Omega_Butter/pi,abs(H_butter))
axis([Omegas 1 0 d2])
xlabel('Frequency (\omega/\pi)')
ylabel('|H(e^{j\omega})|')
title('Butterworth Filter Stopband Detail')



if FINALPLOTS
    print -deps PS9-5-1.eps
end


%Chebyshev Type II:
[N_Chebyshev,Omegan_Chebyshev] = cheb2ord(Omegap,Omegas,Rp,Rs);
[bcheby2,acheby2] = cheby2(N_Chebyshev,Rs,Omegan_Chebyshev);
[H_Chebyshev,Omega_Chebyshev] = freqz(bcheby2,acheby2,8192);

disp('Chebyshev N')
disp(N_Chebyshev)

figure(2)
clf
subplot(311)

plot(Omega_Chebyshev/pi,20*log10(abs(H_Chebyshev)))
xlabel('Frequency (\omega/\pi)')
ylabel('|H(e^{j\omega})|')
title('Chebyshev Type 2 Filter')
axis([0 1 -100 0])
grid
subplot(312)
plot(Omega_Chebyshev/pi,abs(H_Chebyshev))
axis([0 Omegap 1-d1 1+d1])
xlabel('Frequency (\omega/\pi)')
ylabel('|H(e^{j\omega})|')
title('Chebyshev Type 2 Filter Passband Detail')
subplot(313)
plot(Omega_Chebyshev/pi,abs(H_Chebyshev))
axis([Omegas 1 0 d2])
xlabel('Frequency (\omega/\pi)')
ylabel('|H(e^{j\omega})|')
title('Chebyshev Type 2 Filter Stopband Detail')

if FINALPLOTS
    print -deps PS9-5-2.eps
end


%Elliptic filter:

[N_Elliptic,Omegan_Elliptic] = ellipord(Omegap,Omegas,Rp,Rs);
[bElliptic,aElliptic] = ellip(N_Elliptic,Rp,Rs,Omegan_Elliptic);
[H_Elliptic,Omega_Elliptic] = freqz(bElliptic,aElliptic,8192);

disp('Elliptic N')
disp(N_Elliptic)

figure(3)
clf
subplot(311)
```

```
plot(Omega_Elliptic/pi,20*log10(abs(H_Elliptic)))
xlabel('Frequency (\omega/\pi)')
ylabel('|H(e^{j\omega})|')
title('Elliptic Filter')
axis([0 1 -100 0])
grid
subplot(312)
plot(Omega_Elliptic/pi,abs(H_Elliptic))
axis([0 Omegap 1-d1 1+d1])
xlabel('Frequency (\omega/\pi)')
ylabel('|H(e^{j\omega})|')
title('Elliptic Filter Passband Detail')
subplot(313)
plot(Omega_Elliptic/pi,abs(H_Elliptic))
axis([Omegas 1 0 d2])
xlabel('Frequency (\omega/\pi)')
ylabel('|H(e^{j\omega})|')
title('Elliptic Filter Stopband Detail')

if FINALPLOTS
    print -deps PS9-5-3.eps
end

%Part 3
%Butterworth
figure(4)
xlabel('Re(z)')
ylabel('Im(z)')
title('Dzplot of a ButterWorth Filter')
grid
dpzplot(bbutter,abutter)

if FINALPLOTS
    print -deps PS9-5-4.eps
end

%Chebyshev
figure(5)
xlabel('Re(z)')
ylabel('Im(z)')
title('Dzplot of a Chebyshev Filter')
grid
dpzplot(bcheby2,acheby2)

if FINALPLOTS
    print -deps PS9-5-5.eps
end

%Elliptic
figure(6)
xlabel('Re(z)')
ylabel('Im(z)')
title('Dzplot of a Elliptic Filter')
grid
dpzplot(bElliptic,aElliptic)

if FINALPLOTS
    print -deps PS9-5-6.eps
end
```

Code 2: matlab script for Problem 5

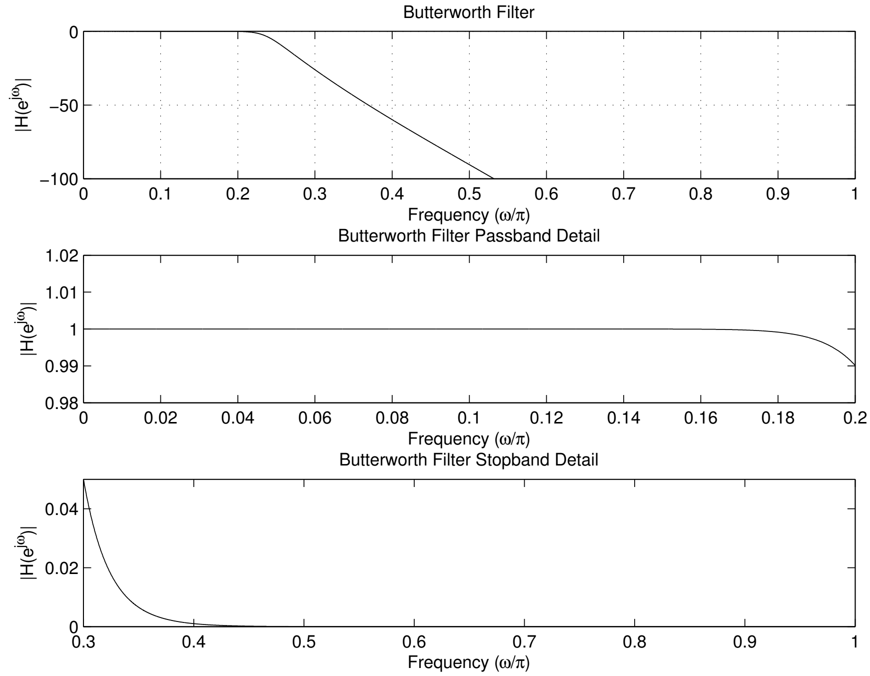

Figure 9.5-3: ButterWorth Filter

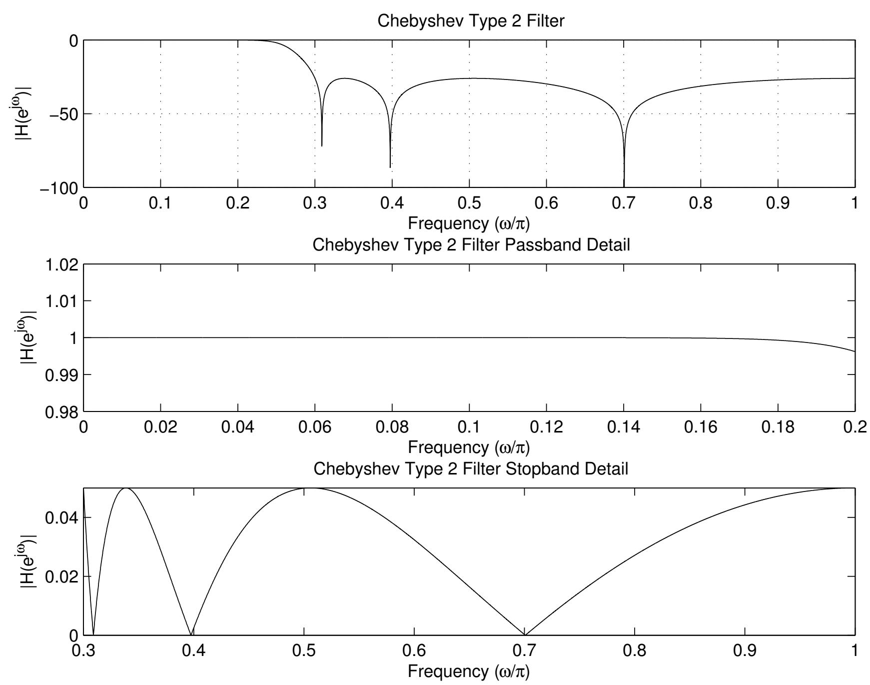

Figure 9.5-4: Chebyshev Filter

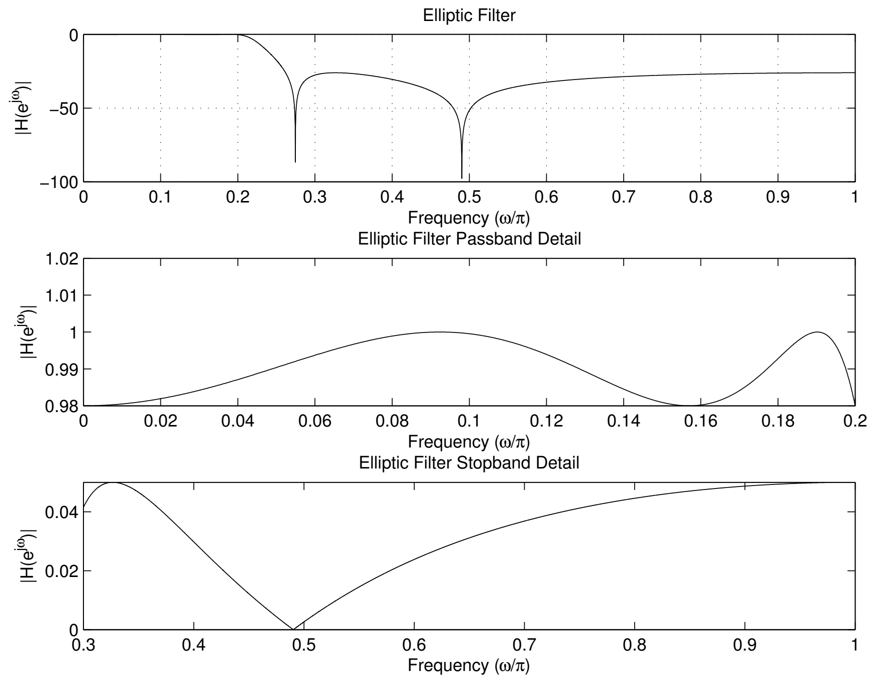

Figure 9.5-5: Elliptic Filter

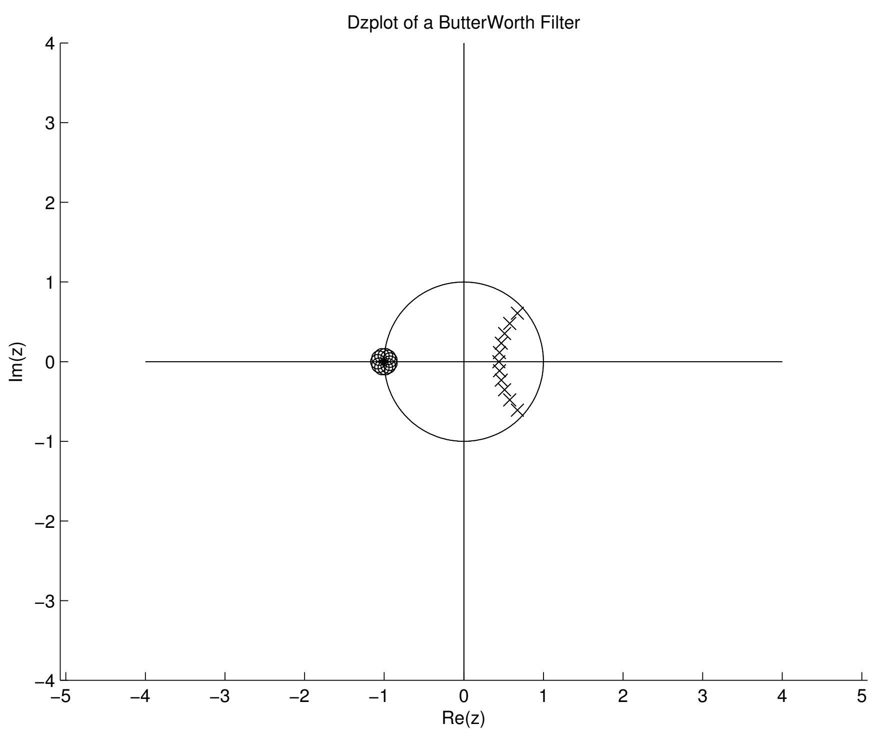

Figure 9.5-6: ButterWorth Zeroplot

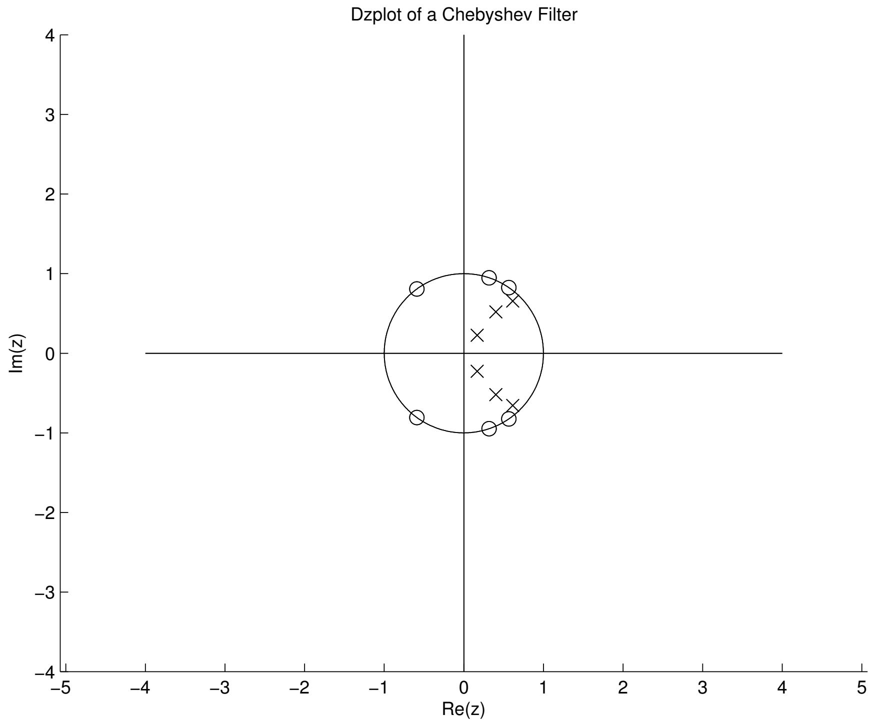

Figure 9.5-7: Chebyshev Zeroplot

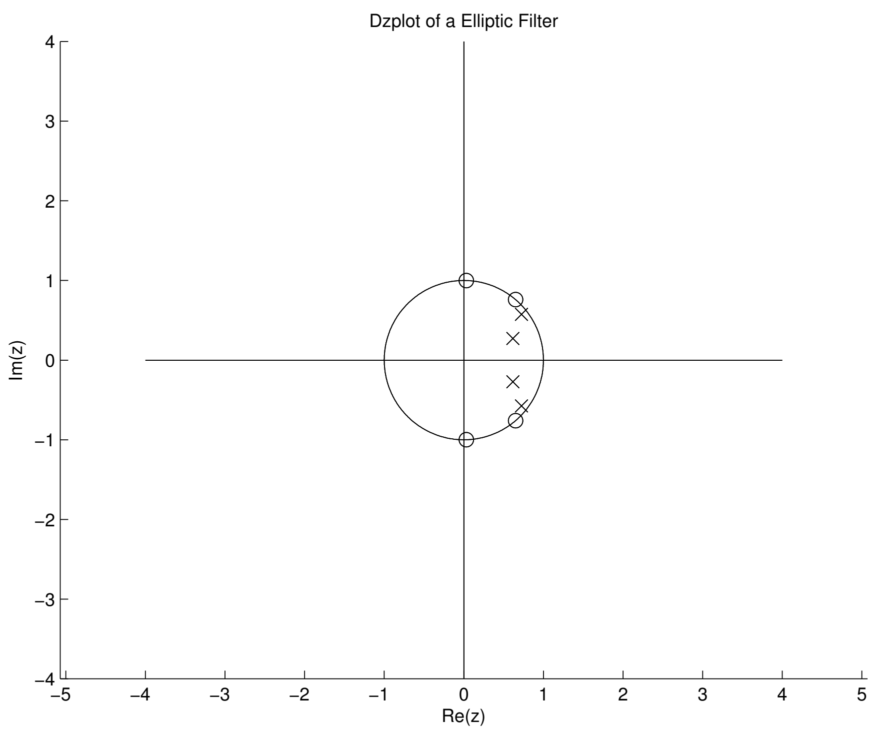

Figure 9.5-8: Elliptic Zeroplot