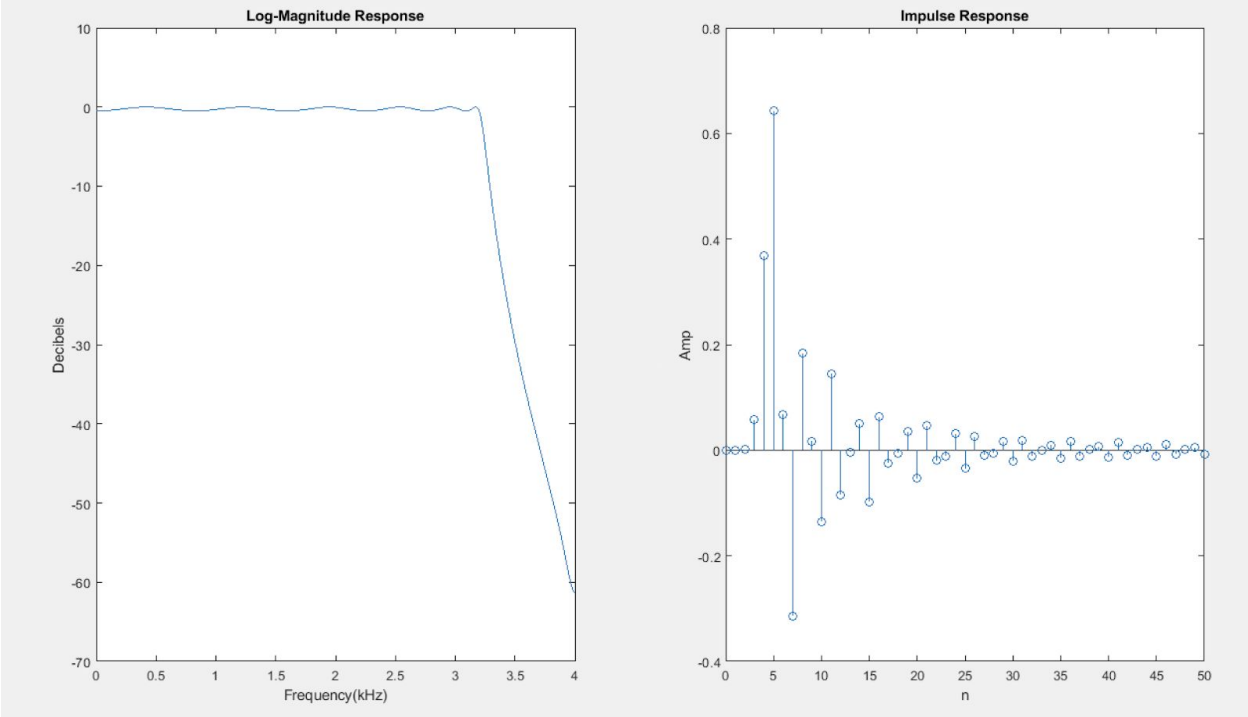
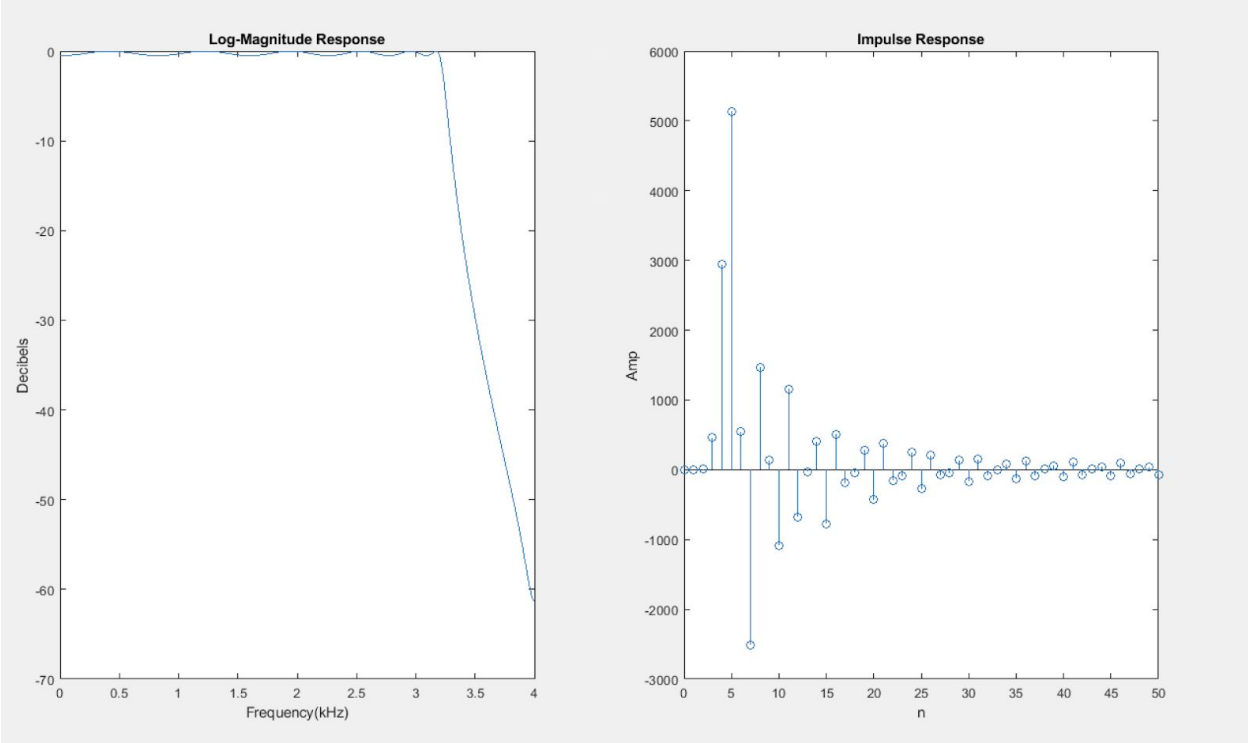
Jeremy Liem
HW 7 EE 442

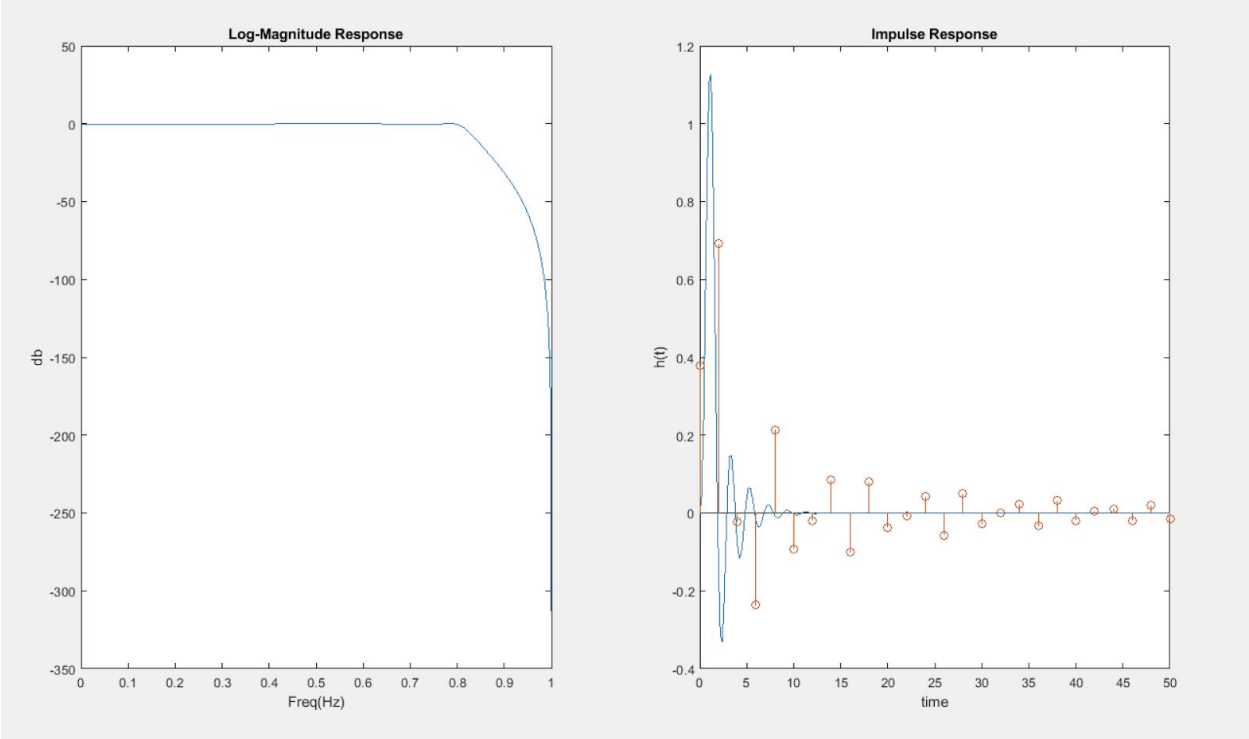
1.



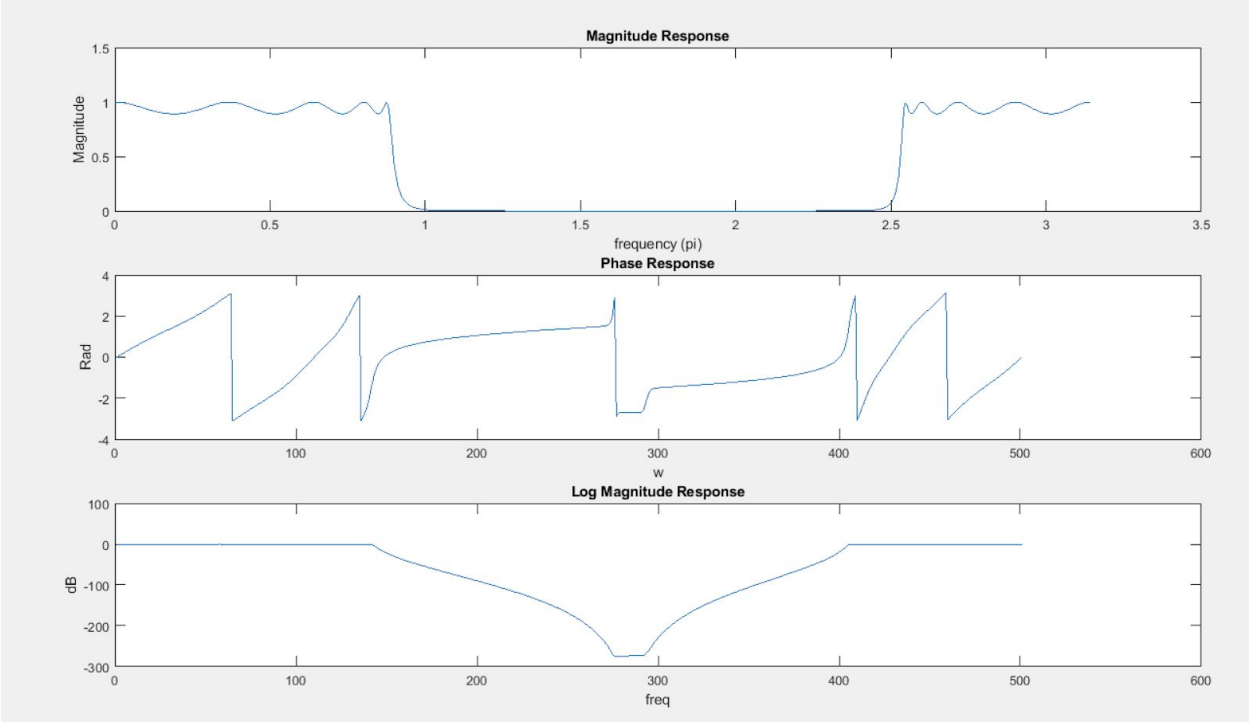


(3) Part 1 and 2 has same Log-Magnitude response. However, they have different impulse response and they differ by an expected scale.

2.



3.


Magnitude Response
Magnitude
frequency (pi)
Phase Response
Rad
w
Log Magnitude Response
dB
freq

4.

4. $p_1 = -3$

$p_2 = -5$

$z_1 = -8$

$$H(s) = \frac{s+8}{(s+3)(s+5)}$$

$$= \frac{A}{s+3} + \frac{B}{s+5} = \frac{5/2}{s+3} + \frac{-3/2}{s+5}$$

a) Impulse Invariance.

$$\frac{5/2}{1 - e^{-3T} z^{-1}} - \frac{3/2}{1 - e^{-5T} z^{-1}} \qquad T = \frac{1}{10}$$

$$= \frac{5/2}{1 - e^{-0.3} z^{-1}} - \frac{3/2}{1 - e^{-0.5} z^{-1}}$$

b) Bilinear Transform

$$s \to \frac{2}{T} \frac{1 - z^{-1}}{1 + z^{-1}}$$

$$H(z) = \frac{\frac{5}{2}}{20\frac{1 - z^{-1}}{1 + z^{-1}} + 3} - \frac{\frac{3}{2}}{20\frac{1 - z^{-1}}{1 + z^{-1}} + 5}$$

Code

1.

```
%% Number 8.21(1);
Fsa = 8000;
Fp = 3200;
Rp = 0.5;
Fs = 3800;
As = 45;
wp = 2*pi*Fp/Fsa;
ws = 2*pi*Fs/Fsa;
T = 1;
omP = wp/T;
omS = ws/T;
[cs, ds] = afd_chb1(omP,omS,Rp,As);
[b,a] = imp_invr(cs,ds,T);
[C,B,A] = dir2par(b,a);
[db,mag,pha,grd,w] = freqz_m(b,a);
[h,n] = impz(b,a,51);

figure;
subplot(1,2,1);
plot(w/(2*pi)*Fsa/1000,db);
title('Log-Magnitude Response');
xlabel('Frequency(kHz)');
ylabel('Decibels');

subplot(1,2,2);
stem(n,h);
title('Impulse Response');
xlabel('n');
ylabel('Amp');
```

```
%% Number 8.21(2)
Fsa = 8000;
Fp = 3200;
Rp = 0.5;
Fs = 3800;
As = 45;
wp = 2*pi*Fp/Fsa;
ws = 2*pi*Fs/Fsa;
T = 1/8000;
omP = wp/T;
omS = ws/T;
[cs, ds] = afd_chb1(omP,omS,Rp,As);
[b,a] = imp_invr(cs,ds,T);
[C,B,A] = dir2par(b,a);
[db,mag,pha,grd,w] = freqz_m(b,a);
[h,n] = impz(b,a,51);

figure;
subplot(1,2,1);
plot(w/(2*pi)*Fsa/1000,db);
title('Log-Magnitude Response');
xlabel('Frequency(kHz)');
ylabel('Decibels');

subplot(1,2,2);
stem(n,h);
title('Impulse Response');
xlabel('n');
ylabel('Amp');
```

2.

```
%8.31
Fsa = 8000;
Fp = 3200;
Rp = 0.5;
Fs = 3800;
As = 45;
wp = 2*pi*Fp/Fsa;
ws = 2*pi*Fs/Fsa;
T = 2;
omP = (2/T)*tan(wp/2);
omS = (2/T)*tan(ws/2);
[cs, ds] = afd_chb1(omP,omS,Rp,As);
[b,a] = bilinear(cs,ds,1/T);
[db,mag,pha,grd,w] = freqz_m(b,a);
N =25;
t = 0:T/10:T*N;
```

```
[ha,x,t] = impulse(cs,ds,t);
[x,n] = impseq(0,0,N);
h = filter(b,a,x);


figure;
subplot(1,2,1);
plot(w/pi,db);
title('Log-Magnitude Response');
xlabel('Freq(Hz)');
ylabel('db');

subplot(1,2,2);
plot(t,ha);
title('Impulse Response');
xlabel('time');
```

```
ylabel('h(t)');
```

```
hold on;
stem(n*T,h);
```

3.

```
w1p = 0.2*pi;
w1s = 0.3*pi;
w2s = 0.7*pi;
w2p = 0.8*pi;
T=1;
W1p = (2/T)*tan(w1p/2);
W1s = (2/T)*tan(w1s/2);
W2s = (2/T)*tan(w2s/2);
W2p = (2/T)*tan(w2p/2);

w0 = (W1s + W2s)/2;
bw = W2p - W1p;
Rp = 1; As = 50;
[N, Wc] = cheb1ord([0.2 0.8], [0.3 0.7], Rp, As, 's');
[Z, P, K] = cheb1ap(N, Rp);
[num,den] = zp2tf(Z,P,K);
[numt, dent] = lp2bs(num, den, w0, bw);

[nt, dt] = bilinear(numt, dent, 1);
[db,mag,pha,grd,w] = freqz_m(nt,dt);

figure;
subplot(3,1,1); plot(w, mag);
title('Magnitude Response');
xlabel('frequency (pi)'); ylabel('Magnitude');
subplot(3,1,2); plot(pha);
title('Phase Response');
xlabel('w'); ylabel('Rad')
subplot(3,1,3); plot(db);
title('Log Magnitude Response'); xlabel('freq');
ylabel('dB');
```