Digital Signal Processing MATLAB HW2 - q5

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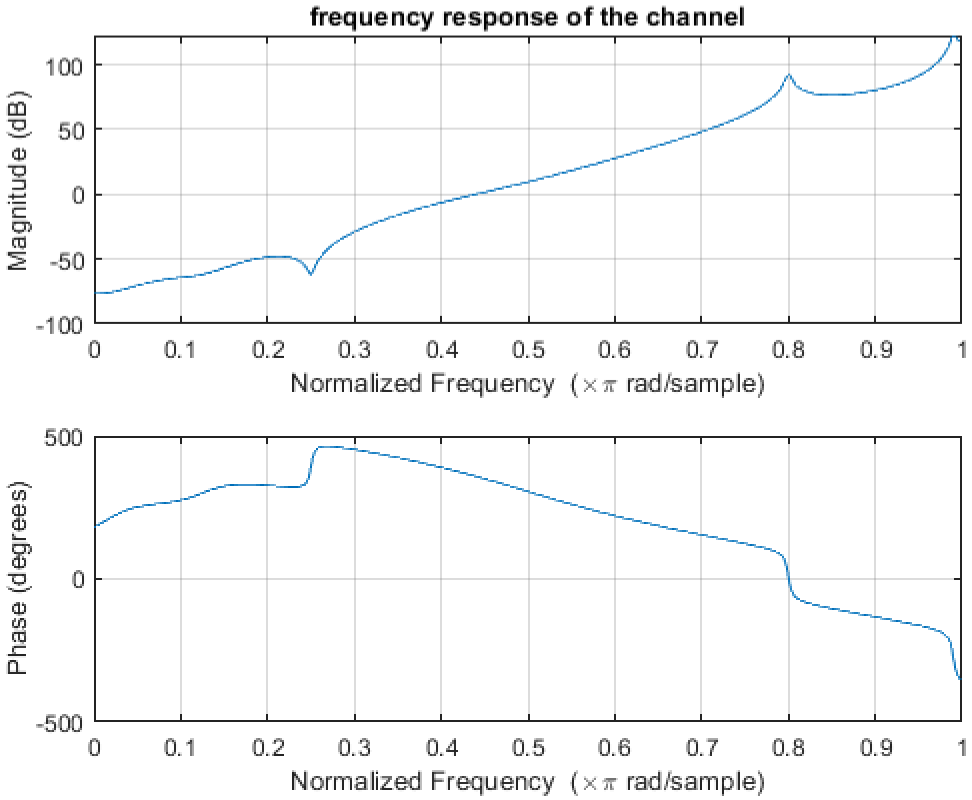
Clear recent data

```
clear; close all; clc;
```

Equalizer

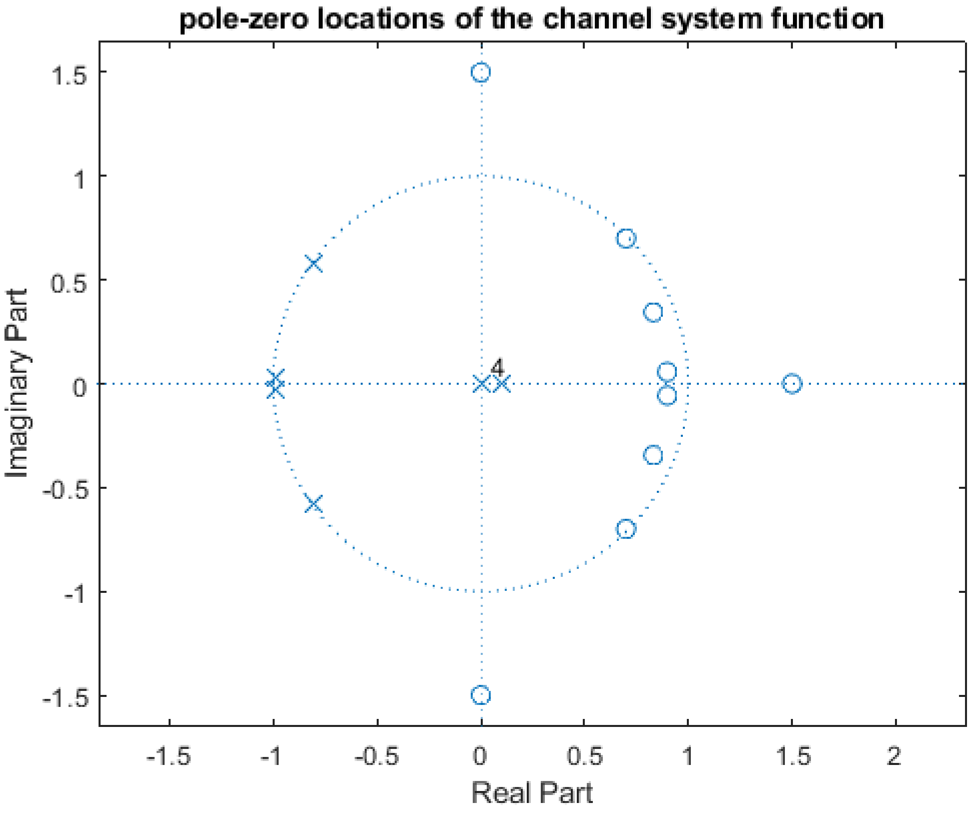
PART 1

```
a = load('a.mat');
a = cell2mat(struct2cell(a));
b = load('b.mat');
b = cell2mat(struct2cell(b));

figure(1);
freqz(b,a);
title("frequency response of the channel");
```



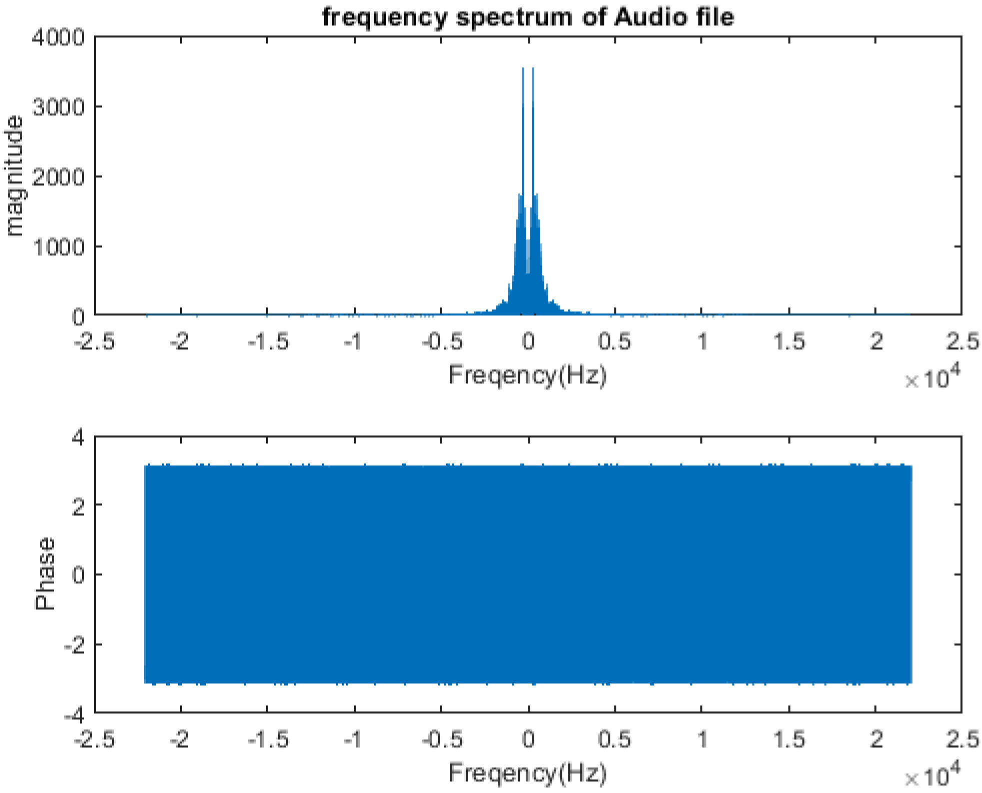
PART2

```
figure(2);
zplane(b,a);
title("pole-zero locations of the channel system function");
```



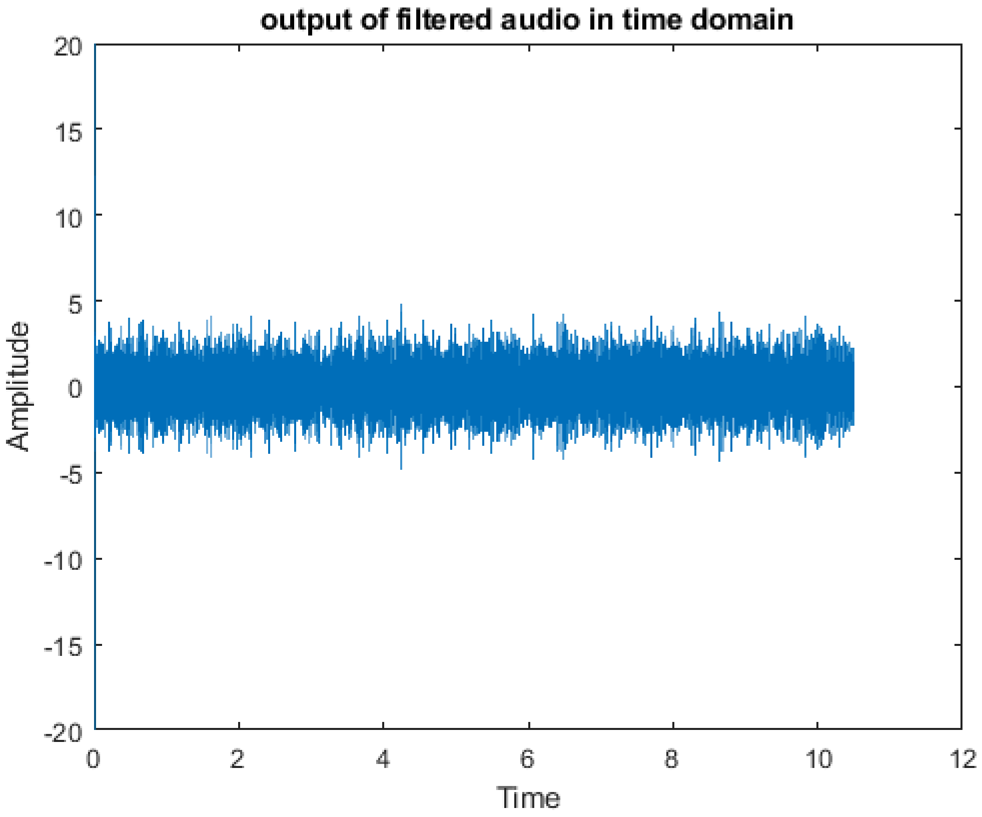
PART3

```
audioFile = 'HW2_Q6_voice.wav';
[audio , Fs] = audioread(audioFile);
L = length(audio);
slength = L/Fs;
t = (linspace(0, slength, L))';
freq_domain = fftshift(fft(audio));
freq_L = length(freq_domain);
freq_grid = (-freq_L/2 : freq_L/2-1) / (freq_L/Fs);

figure(3);
subplot(2,1,1);
plot(freq_grid,abs(freq_domain));
xlabel("Freqency(Hz)");
ylabel("magnitude");
title("frequency spectrum of Audio file");
subplot(2,1,2);
plot(freq_grid,angle(freq_domain));
xlabel("Freqency(Hz)");
ylabel("Phase");
% sound(audio,Fs);      % to hear the original audio uncomment this
 line
```

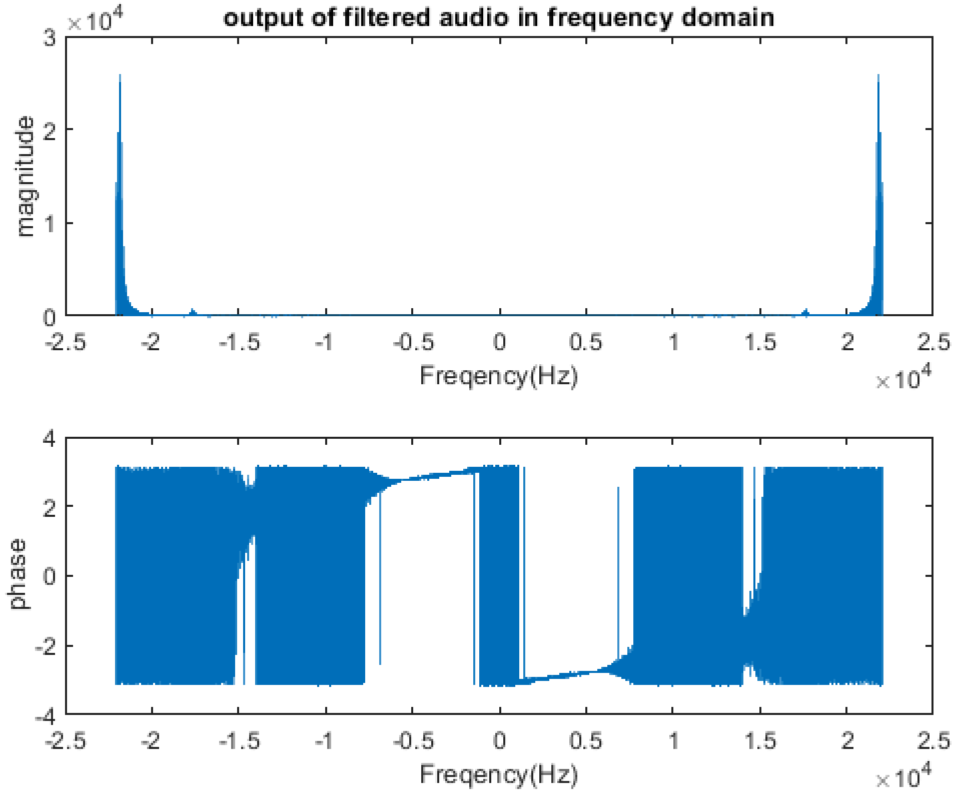


PART4

```
y = filter(b,a,audio);
% Time Domain
figure(4);
plot(t,y);
title("output of filtered audio in time domain");
xlabel('Time');
ylabel('Amplitude');
ylim([-20,20]);
% Frequency Domain
y_f = fftshift(fft(y));
figure(5);
subplot(2,1,1);
plot(freq_grid,abs(y_f));
title("output of filtered audio in frequency domain");
xlabel("Freqency(Hz)");
ylabel("magnitude");
subplot(2,1,2);
plot(freq_grid,angle(y_f));
xlabel("Freqency(Hz)");
ylabel("phase");
% sound(y,Fs);          % to hear the audio after filter uncomment
 this
```



output of filtered audio in time domain

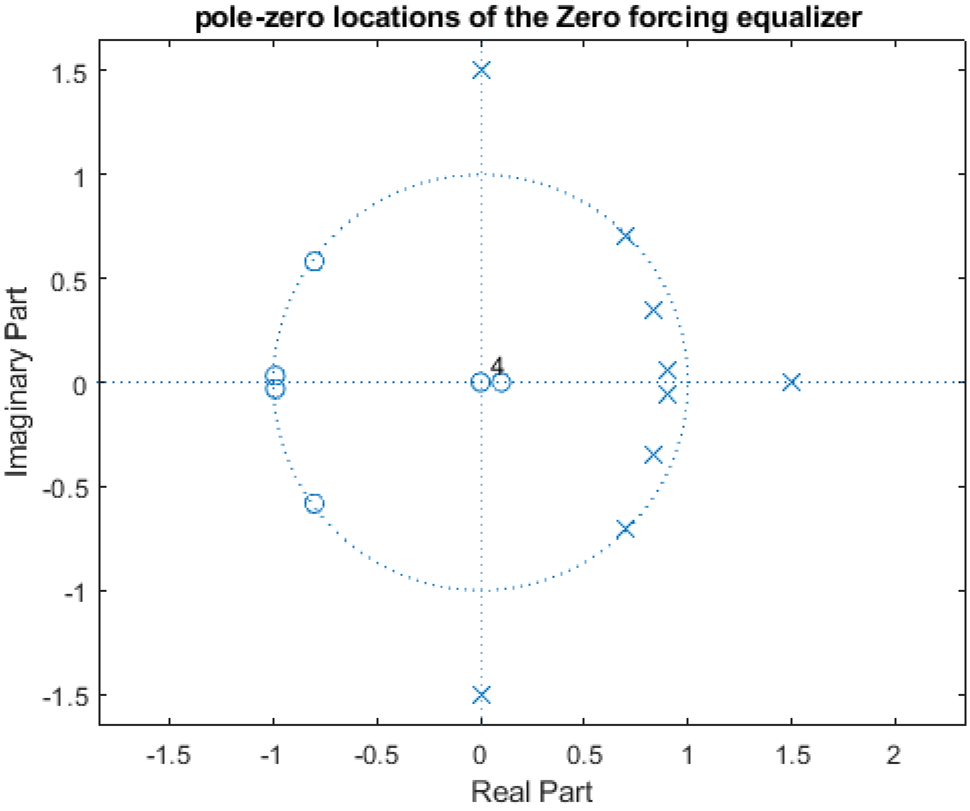


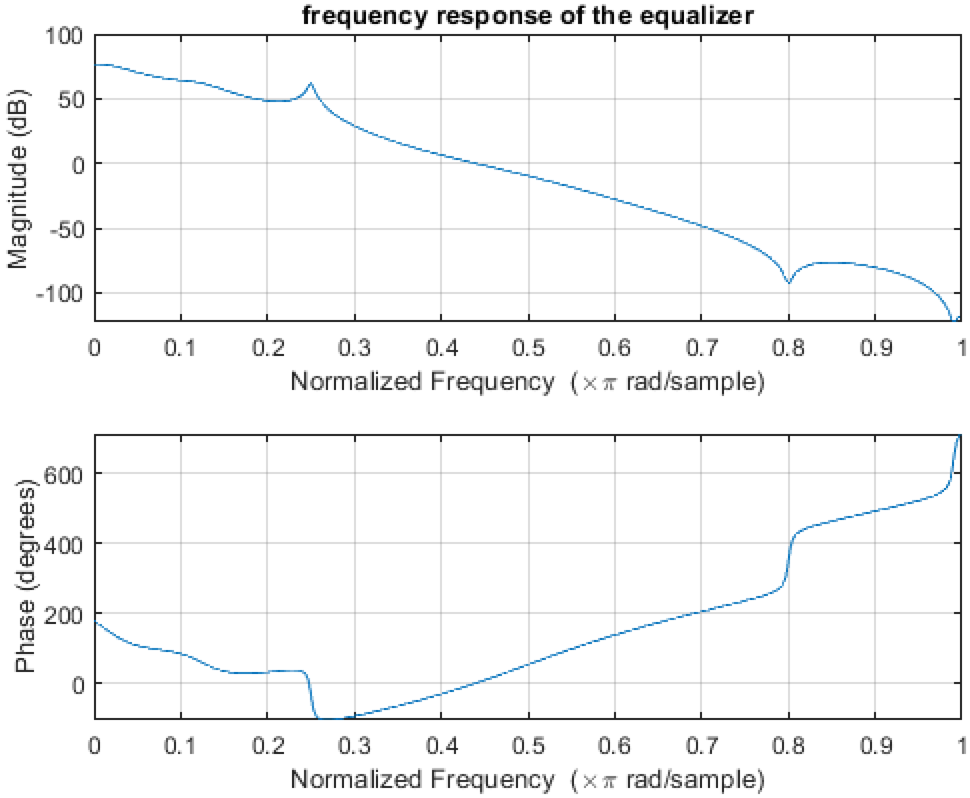
output of filtered audio in frequency domain

PART5

Design Zero forcing equalizer

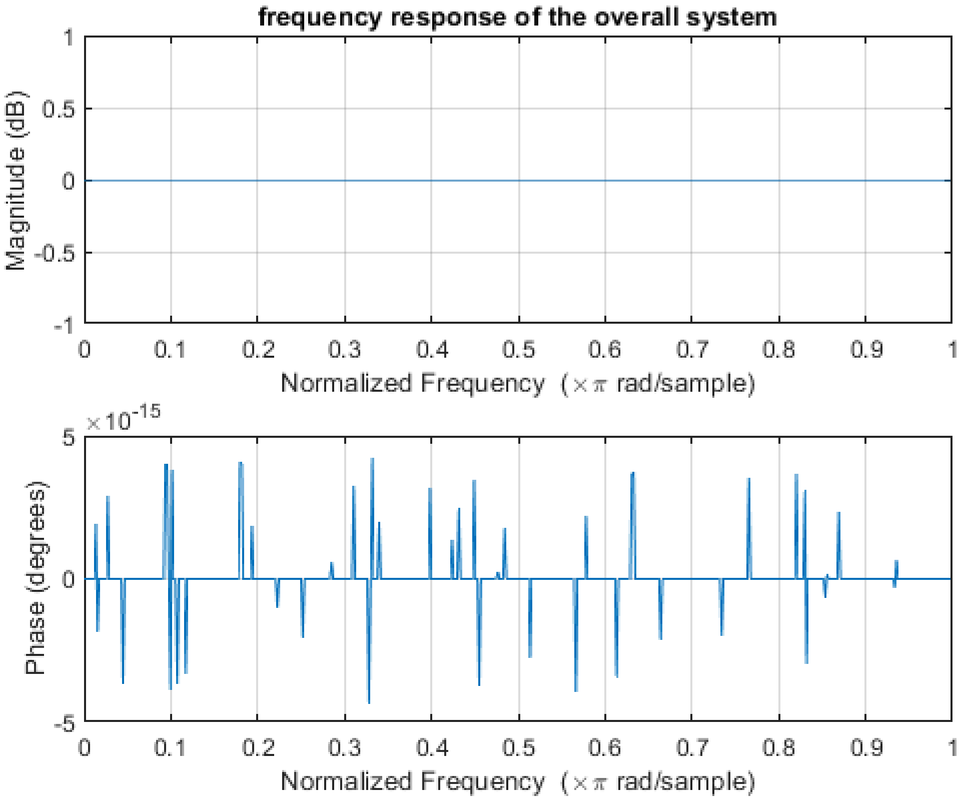
```
b_eq = a;
a_eq = b;
figure(6);
zplane(b_eq,a_eq);
title("pole-zero locations of the Zero forcing equalizer ");
y_eq = filter(b_eq,a_eq,y);

figure(7);
freqz(b_eq,a_eq);
title("frequency response of the equalizer");
```





PART6

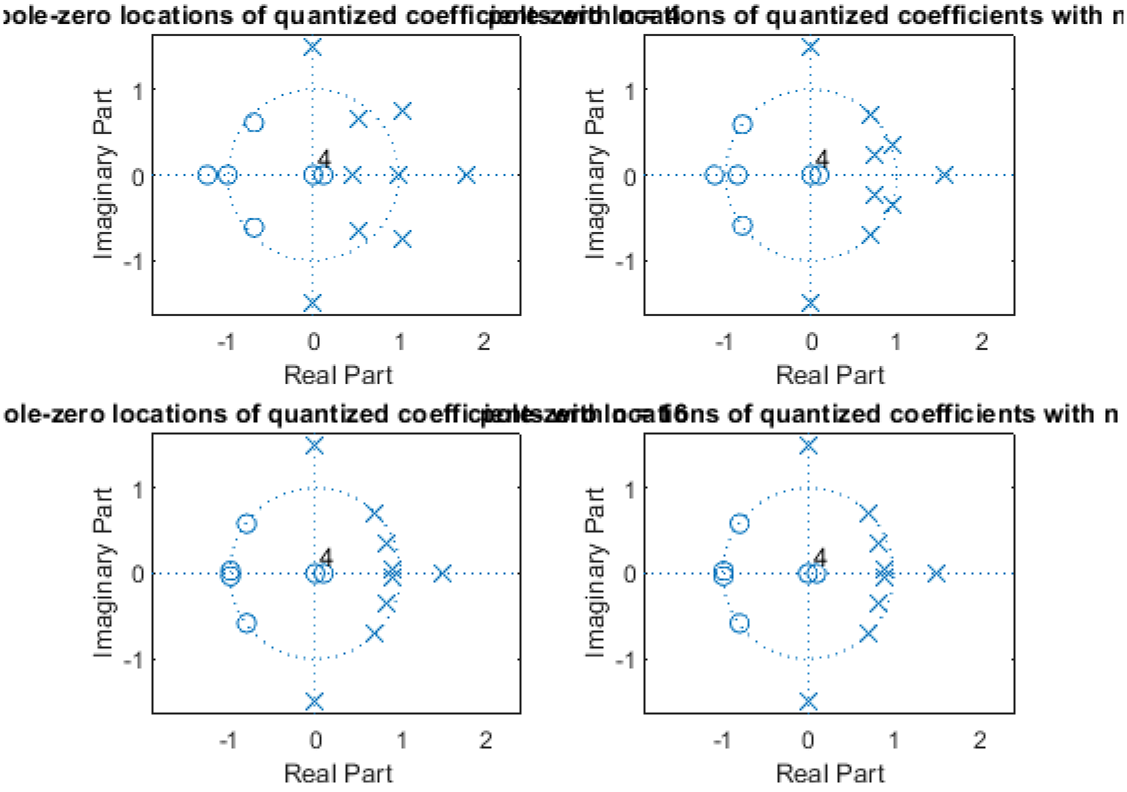
```
a_overal = conv(a,a_eq);
b_overal = conv(b,b_eq);
figure(8);
freqz(b_overal,a_overal);
title("frequency response of the overall system");
```



PART8

```
n4 = 4;
range4 = 2^(n4-1);
aq4 = round(a_eq*range4)/range4 ;
bq4 = round(b_eq*range4)/range4 ;

n8 = 8;
range8 = 2^(n8-1);
aq8 = round(a_eq*range8)/range8 ;
bq8 = round(b_eq*range8)/range8 ;

n16 = 16;
range16 = 2^(n16-1);
aq16 = round(a_eq*range16)/range16 ;
bq16 = round(b_eq*range16)/range16 ;

n32 = 32;
range32 = 2^(n32-1);
aq32 = round(a_eq*range32)/range32 ;
bq32 = round(b_eq*range32)/range32 ;

figure(9);
subplot(2,2,1);
zplane(bq4,aq4);
```

```
title("pole-zero locations of quantized coefficients with n = 4");
subplot(2,2,2);
zplane(bq8,aq8);
title("pole-zero locations of quantized coefficients with n = 8");
subplot(2,2,3);
zplane(bq16,aq16);
title("pole-zero locations of quantized coefficients with n = 16");
subplot(2,2,4);
zplane(bq32,aq32);
title("pole-zero locations of quantized coefficients with n = 32");
```



PART7

```
function [dynamic_range] = quantize_m(v,n)
    range = 2^(n-1);
    for i = 0:length(v)
       if v(i)>max
           max = v(i);
       end
       if v(i)<min
           min = v(i);
       end
    end
    dynamic_range = max - min;

end
```

Published with MATLAB® R2020b