Use MATLAB to plot the frequency response (both magnitude and phase) of the following discrete-time filters.

A. $h[n] = \delta[n] + 2\delta[n-1] + 3\delta[n-2] + 4\delta[n-3] + 3\delta[n-4] + 2\delta[n-5] + \delta[n-6]$

B. $y[n] + y[n-1] + 0.8y[n-2] = x[n]$

The filter defined by

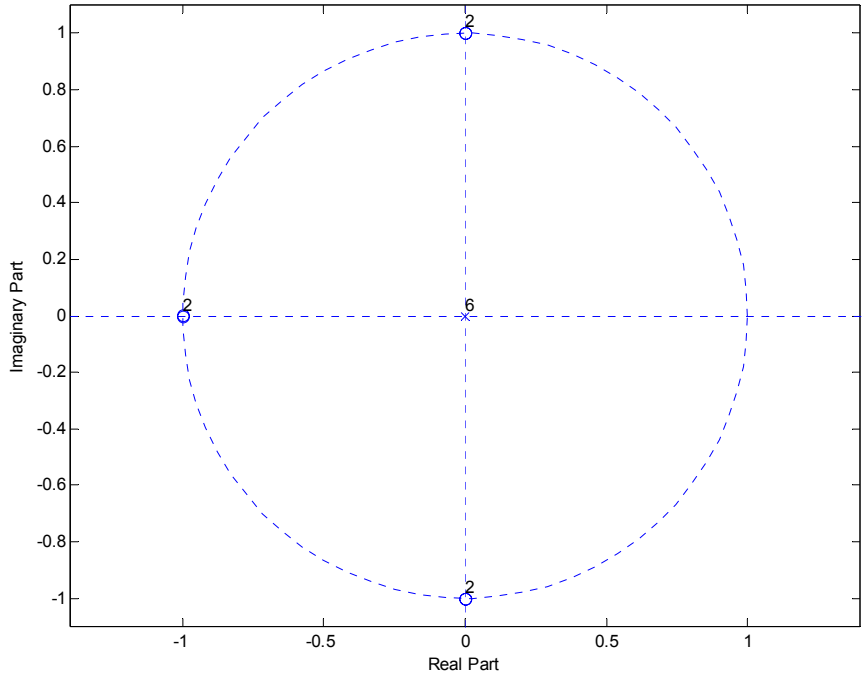
$$h[n] = \delta[n] + 2\delta[n-1] + 3\delta[n-2] + 4\delta[n-3] + 3\delta[n-4] + 2\delta[n-5] + \delta[n-6]$$

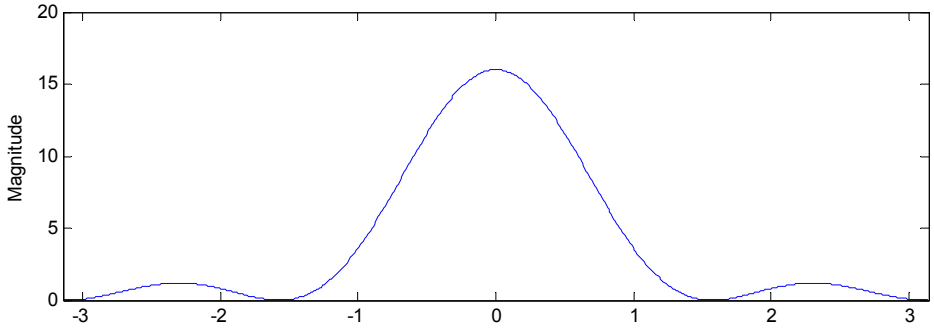
can be represented by the following transfer function.

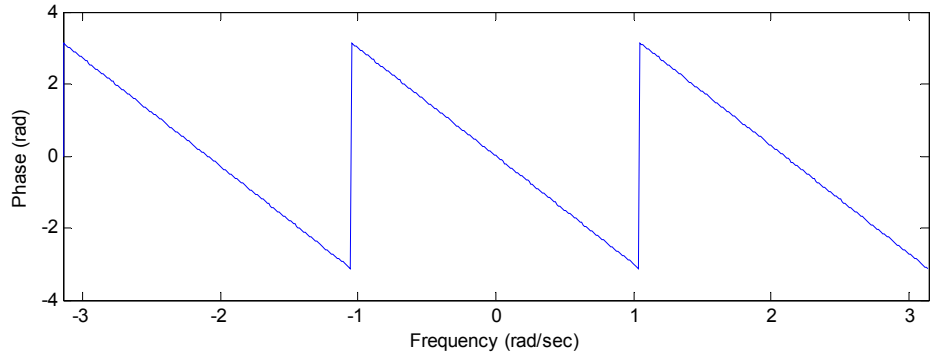
$$H(z) = 1 + 2z^{-1} + 3z^{-2} + 4z^{-3} + 3z^{-4} + 2z^{-5} + z^{-6} = \frac{z^6 + 2z^5 + 3z^4 + 4z^3 + 3z^2 + 2z^1 + 1}{z^6}$$

<u>Matlab Code</u>

```
num = [1 2 3 4 3 2 1];
den = [1 0 0 0 0 0 0];
% pole-zero plot
figure(1);
zplane(num,den);
% frequency response
ww = -pi:0.01:pi;
[H,W] = freqz(num,den,ww);
figure(2);
subplot(2,1,1)
plot(W,abs(H))
ylabel('Magnitude')
% plot only from -pi to pi
H1 = gca;
set(H1,'xlim',[-pi pi])
subplot(2,1,2);
plot(W,angle(H))
xlabel('Frequency (rad/sec)')
ylabel('Phase (rad)')
% plot only from -pi to pi
H2 = gca;
set(H2,'xlim',[-pi pi])
```







We notice from the frequency-response plots, this FIR filter has linear phase (although, in this plot, it is wrapped around 180°, or $\pm\pi$. Remember, $180^o = -180^o$).

The filter defined by

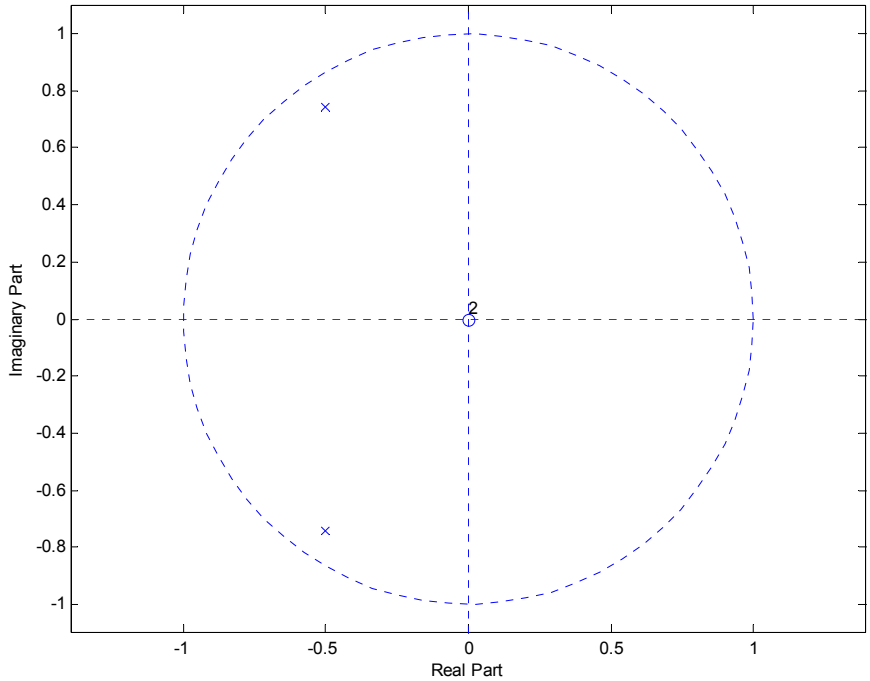
$$y[n] + y[n-1] + 0.8y[n-2] = x[n]$$

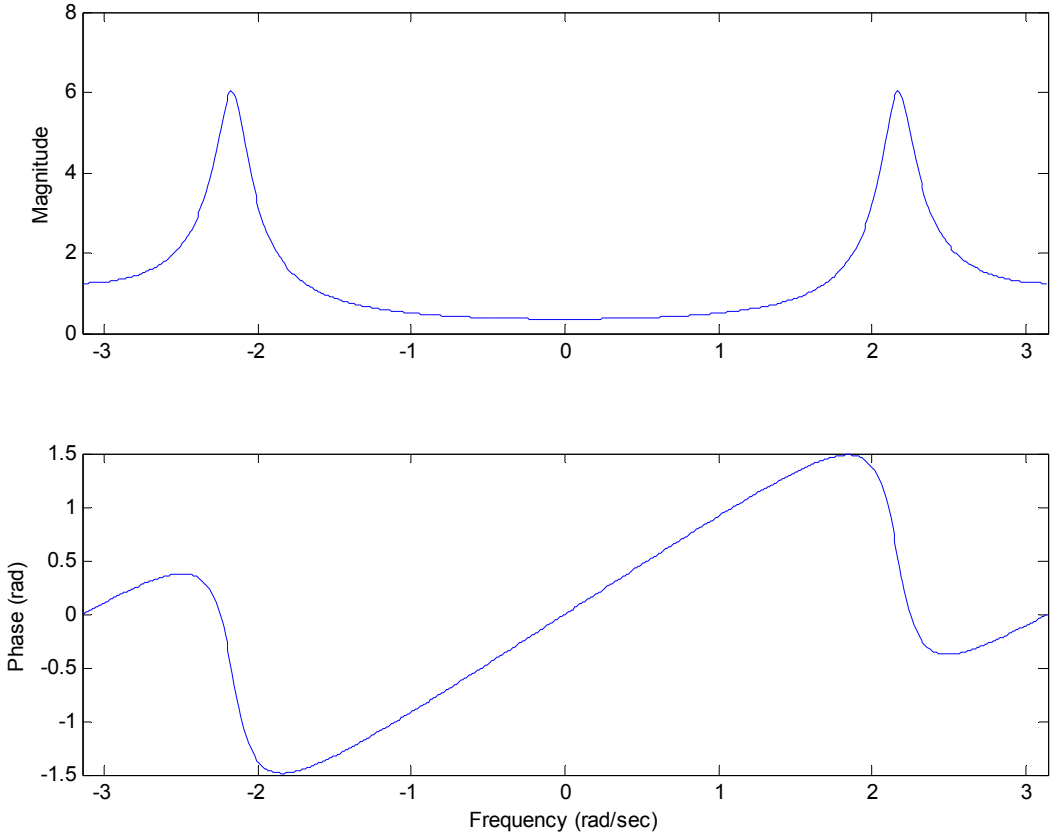
can be represented by the following transfer function.

$$H(z) = \frac{z^2}{x^2 + z + 0.8}$$

<u>Matlab Code</u>

```
num = [1 0 0];
den = [1 1 0.8];
% pole-zero plot
figure(3);
zplane(num,den);
% frequency response
ww = -pi:0.01:pi;
[H,W] = freqz(num,den,ww);
figure(4);
subplot(2,1,1)
plot(W,abs(H))
ylabel('Magnitude')
% plot only from -pi to pi
H1 = gca;
set(H1,'xlim',[-pi pi])
subplot(2,1,2);
plot(W,angle(H))
xlabel('Frequency (rad/sec)')
ylabel('Phase (rad)')
% plot only from -pi to pi
H2 = gca;
set(H2,'xlim',[-pi pi])
```


Imaginary Part
Real Part
2


Magnitude
Phase (rad)
Frequency (rad/sec)