

1. (15%) Find the inverse z-transform of (2). Please state the ROC. causal system, the ROC is the region outside of the outermost circle.

ROC corresponds to $|z| > |0.7686 \pm 0.3338i| = 0.838$.

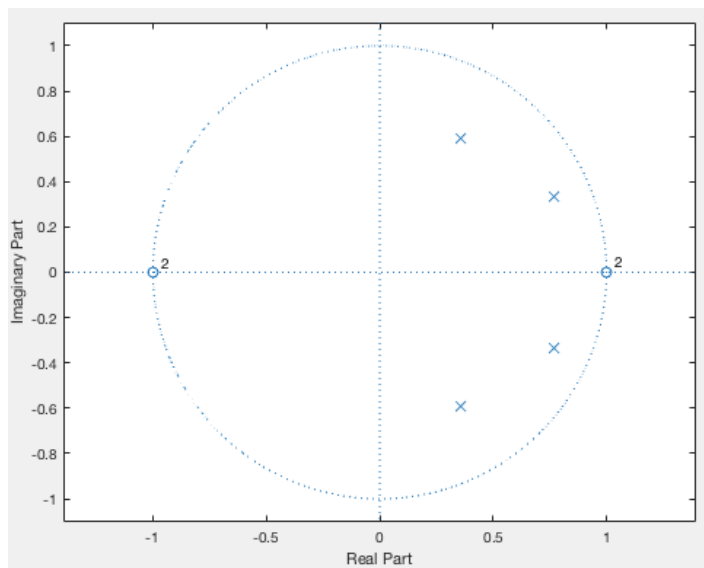
Since

$$H(z) = 0.2929 + \frac{-0.1045 - 0.1596i}{1 - (0.7686 - 0.3338i)z^{-1}} + \frac{-0.1045 + 0.1596i}{1 - (0.7686 + 0.3338i)z^{-1}} \\ + \frac{0.0068 - 0.4093i}{1 - (0.3575 + 0.5889i)z^{-1}} + \frac{0.0068 + 0.4093i}{1 - (0.3575 - 0.5889i)z^{-1}}$$

then

$$h(t) = 0.2929\delta[n] + (-0.1045 - 0.1596i)(0.7686 - 0.3338i)^n u[n] + (-0.1045 + 0.1596i)(0.7686 + 0.3338i)^n u[n] \\ + (0.0068 - 0.4093i)(0.3575 + 0.5889i)^n u[n] + (0.0068 + 0.4093i)(0.3575 - 0.5889i)^n u[n]$$

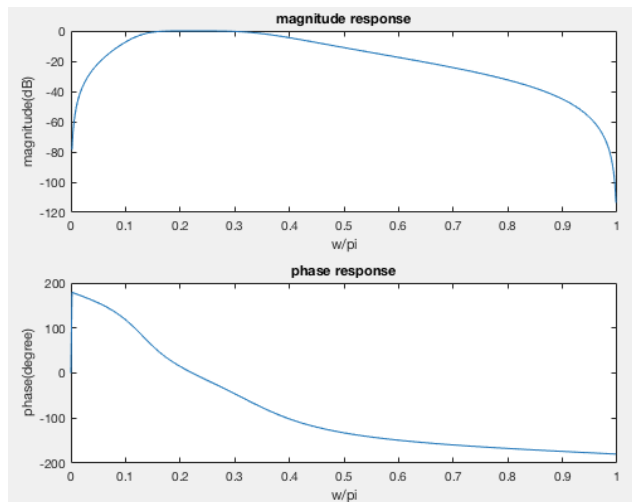
2. (20%) Find and plot the locations of poles and zeros.



zeros: (1, 0) and (-1, 0)
poles: $(0.3575, \pm 0.5889i)$
and $(0.7686, \pm 0.3338i)$

3. (15%) Evaluate and plot the magnitude and phase response.

roughly a bandpass filter

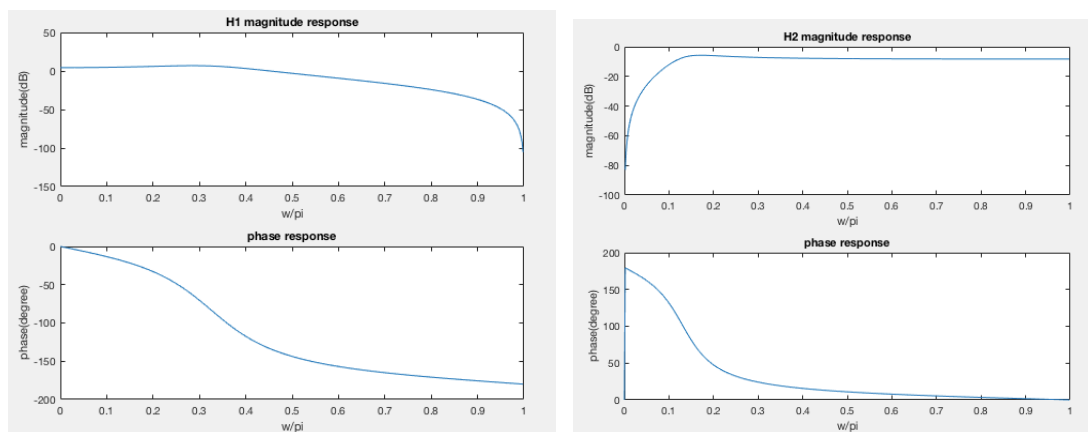


4. (15%) Find a representation of this transfer function as a cascade of two second-order sections with real coefficients.

$$H(z) = \sqrt{0.0976} \frac{1 + 2z^{-1} + z^{-2}}{1 - 0.715z^{-1} + 0.4746z^{-2}} \sqrt{0.0976} \frac{1 - 2z^{-1} + z^{-2}}{1 - 1.5372z^{-1} + 0.7022z^{-2}}$$

$$= X_1(z)X_2(z)$$

5. (20%) Evaluate and plot the magnitude response of each section in 4.



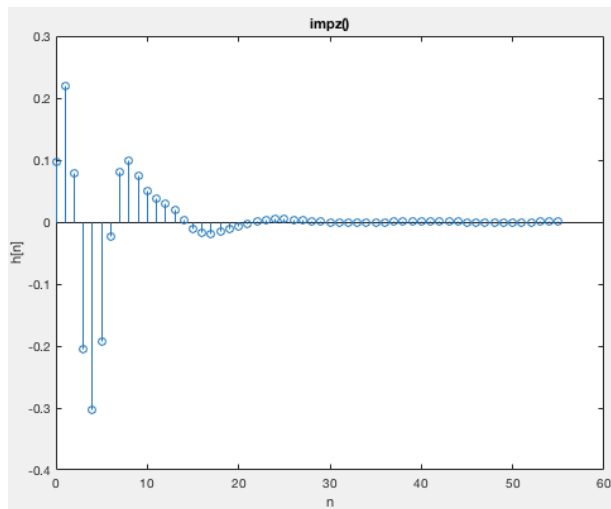
H1 and H2 are correspond to $X_1(z)$ and $X_2(z)$ respectively.

$X_1(z)$ is like a lowpass filter.

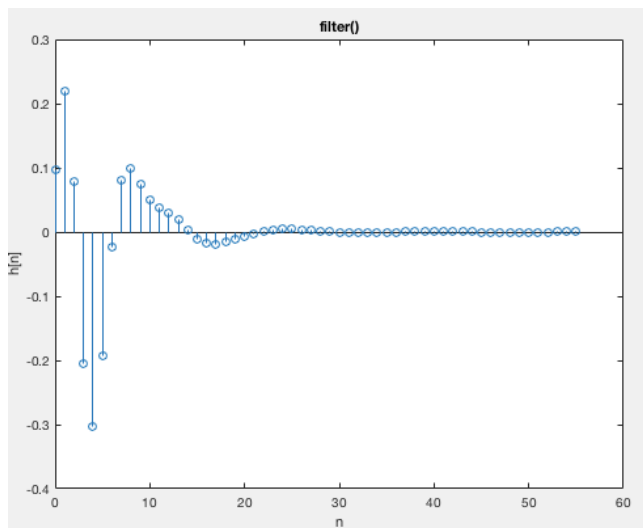
$X_2(z)$ is like a highpass filter.

6. (15%) Determine the impulse response of the system by obtaining the output for an input $x[n] = \delta[n]$, and compare it with the result of 1.

using the command `impz()`



using the matlab command `filter()`



they are all the same!