Signal and System
MATLAB Homework #3

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1 Problem 1

(a) **Find the inverse z-transform of (2). Please state the ROC.**

By using `residuez` command in Octave, we obtain

$$H(z) \approx \frac{0.00682 + 0.40930\text{i}}{1 - (0.35750 - 0.58890\text{i})z^{-1}} + \frac{0.00682 - 0.40930\text{i}}{1 - (0.35750 + 0.58890\text{i})z^{-1}} + \frac{-0.10445 - 0.15963\text{i}}{1 - (0.76860 - 0.33380\text{i})z^{-1}} + \frac{-0.10445 + 0.15963\text{i}}{1 - (0.76860 + 0.33380\text{i})z^{-1}} + 0.29287$$

so

$$\begin{aligned}\mathcal{Z}^{-1}\{H(z)\} = {} & (0.00682 + 0.40930\text{i})(0.35750 - 0.58890\text{i})^n \\ & + (0.00682 - 0.40930\text{i})(0.35750 + 0.58890\text{i})^n \\ & + (-0.10445 - 0.15963\text{i})(0.76860 + 0.33380\text{i})^n \\ & + (-0.10445 + 0.15963\text{i})(0.76860 - 0.33380\text{i})^n + 0.29287\delta[n]\end{aligned}$$

The maximum absolute value of the poles is about 0.83795. Since the system is causal, the ROC is $|z| > 0.83795$

(b) **Find and plot the locations of poles and zeros.**

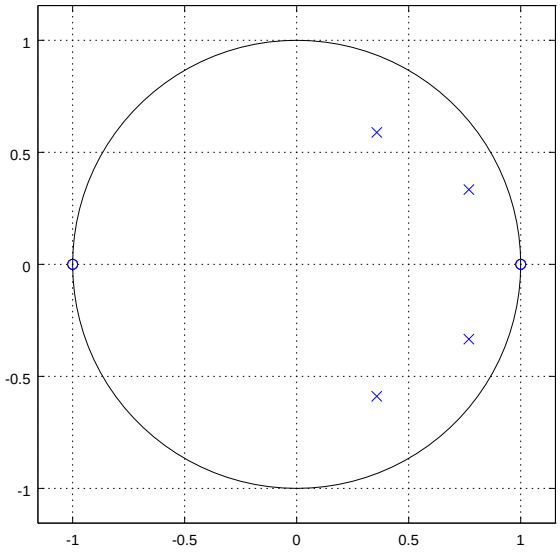
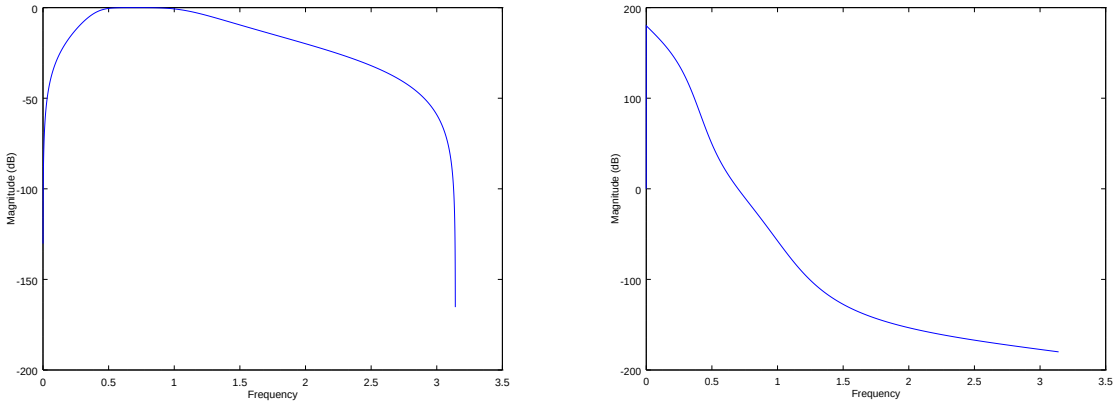


Figure 1: Plot of the poles and zeros.

(c) **Evaluate and plot the magnitude and phase response.**

The frequency response is simply $H(e^{i\omega})$. Use `freqz` to plot the frequency response.



(a) Magnitude response

(b) Phase response

Figure 2: Frequency response.

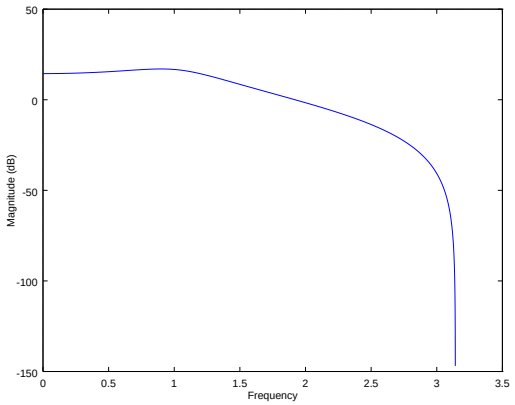
(d) **Find a representation of this transfer function as a cascade of two second-order sections with real coefficients.**

By using the `zp2sos` command, we obtain

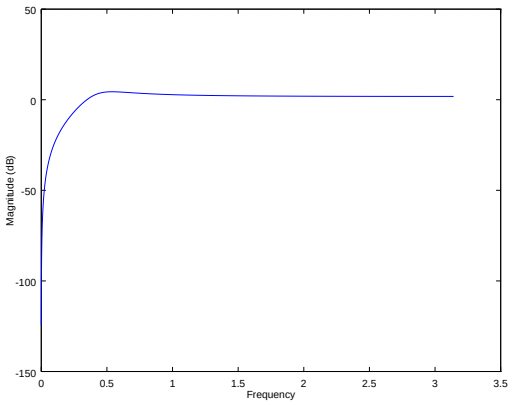
$$H(z) = 0.0976 \left(\frac{1 + 2z^{-1} + 1z^{-2}}{1 - 0.71500z^{-1} + 0.47461z^{-2}} \right) \left(\frac{1 - 2z^{-1} + 1z^{-2}}{1 - 1.53720z^{-1} + 0.70217z^{-2}} \right)$$
$$= 0.0976 H_1(z) H_2(z)$$

(e) **Evaluate and plot the magnitude response of each section in 4.**

Their magnitude response is simply $H_1(e^{\mathrm{i}\omega})$ and $H_2(e^{\mathrm{i}\omega})$



(a) Magnitude response of H_1



(b) Magnitude response of H_2

(f) **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.**

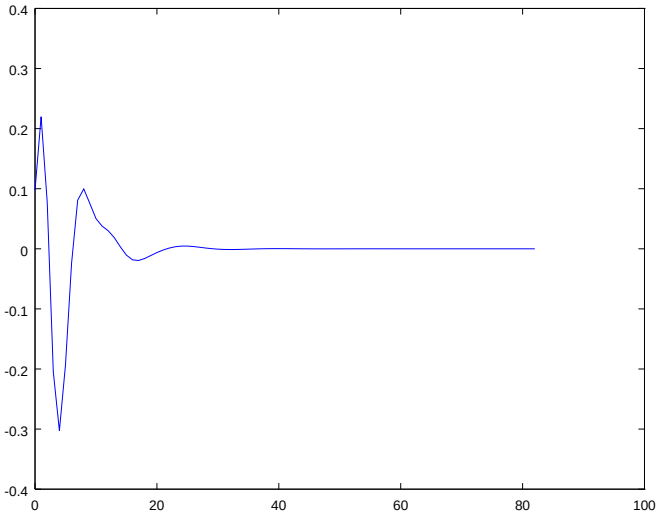


Figure 4: Impulse response of H

They are identical.