4.9 Problems

For the problems in this chapter, you may use matlab's roots *function or your calculator to determine poles and zeros.*

1. A particular discrete-time system can be represented by the following difference-equation:

$$y[n] + \frac{1}{2}y[n-1] - \frac{3}{16}y[n-2] \quad = \quad x[n] + x[n-1] + \frac{1}{4}x[n-2]$$

   (a) Determine the system function, including the region of convergence.

   (b) Determine the poles and zeros of this system.

   (c) Is this system BIBO stable?

   (d) Put the system function into factored form:

$$H(z) \quad = \quad \left(\frac{b_0}{a_0}\right)\left(\frac{(1-\xi_1 z^{-1})(1-\xi_2 z^{-1})}{(1-\lambda_1 z^{-1})(1-\lambda_2 z^{-1})}\right)$$

2. Determine the transfer function of each of the following causal LTI discrete-time systems described by the difference equations. Express each transfer function in factored form and sketch its pole-zero plot. Is the corresponding system BIBO stable?

   (a) $y[n] = 5x[n]+9.5x[n-1]+1.4x[n-2]-24x[n-3]+0.1y[n-1]-0.14y[n-2]-0.49y[n-3]$.

   (b) $y[n] = 5x[n]+16.5x[n-1]+14.7x[n-2]-22.04x[n-3]-33.6x[n-4]+0.5y[n-1]-0.1y[n-2]$ $-0.3y[n-3]+0.0936y[n-4]$.

3. A causal LTI system has impulse response:

$$h[n] \quad = \quad n\left(\frac{1}{3}\right)^n u[n] + \left(-\frac{1}{4}\right)^n u[n].$$

   For this system determine:

   - The system function $H(z)$, including the region of convergence.
   - The difference equation.
   - A list of poles and zeros along with the system gain b_0/a_0.

   In addition, determine if this system is BIBO stable.