Exercises Week 13

DSP

1. Design two filters of order 2 of the following types, and write their equation:

   - a low-pass filter
   - a band-pass filter with central frequency around the frequency $\omega = \frac{3\pi}{4}$

2. Which of the following filters has a linear-phase?

   a. $H(z) = 7 + 3z^{-1} + z^{-2} + 7z^{-3} + 3z^{-4} + z^{-5}$
   b. $H(z) = \frac{1+2z^{-1}+z^{-2}}{1-2z^{-1}+z^{-2}}$
   c. $H(z) = 1 + 2z^{-1} + z^{-2}$
   d. $H(z) = 1 - 2z^{-1} + z^{-2}$
   e. $H(z) = 1 - 2z^{-1} - 2z^{-2} + z^{-3}$
   f. $H(z) = 1 + 2z^{-1} + 7z^{-2} - 2z^{-2} - z^{-3}$
   g. $H(z) = 1 - z^{-1}$
   h. $H(z) = 1 - z^{-2}$

3. Consider the causal system with the following equation:

$$y[n] - 0.7y[n-1] + 0.2y[n-2] = 2x[n] - x[n-2]$$

   a. Draw the pole-zero diagram and indicate the Region Of Convergence
   b. Find the system function H(z) and characterize the system with respect to:
      - stability
      - length of impulse response
      - implementation (recursive or not)
   c. Find the impulse response
   d. Find the output signal $y[n]$ if the input signal is the unit step

4. Draw the implementation structure of one of the filters of exercise 1 in the form:

   Direct-Form I / Direct-Form II / Direct-Form I Transposed / Direct-Form II Transposed