

# 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