# <u>EE 5410 Signal Processing</u>

Semester A 2017-2018

**Assignment 2**

**Due Date: <u>14 November 2017</u>**

1. Consider a linear time-invariant (LTI) system with impulse response $h[n]$. The discrete-time Fourier transform (DTFT) of $h[n]$ is:

$$H(e^{j\omega}) = \frac{e^{-2j\omega}}{1 + 0.7e^{-j\omega} + 0.1e^{-2j\omega}}$$

   (a) Determine the transfer function $H(z)$ and its region of convergence (ROC).
   (b) Write down the difference equation that relates input $x[n]$ and output $y[n]$.
   (c) Determine the impulse response $h[n]$.

2. Consider a causal LTI system whose system function is

$$H(z) = \frac{1 - \frac{1}{5}z^{-1}}{\left(1 - \frac{1}{2}z^{-1} + \frac{1}{3}z^{-2}\right)\left(1 + \frac{1}{4}z^{-1}\right)}$$

   Draw one signal flow graph for the system in each of the following forms:

   (a) Direct form
   (b) Canonic form
   (c) Cascade form using canonic form sections
   (d) Parallel form using canonic form sections

3. Figure 1 shows the block diagram representation of a causal LTI discrete-time system with input $x[n]$ and output $y[n]$.

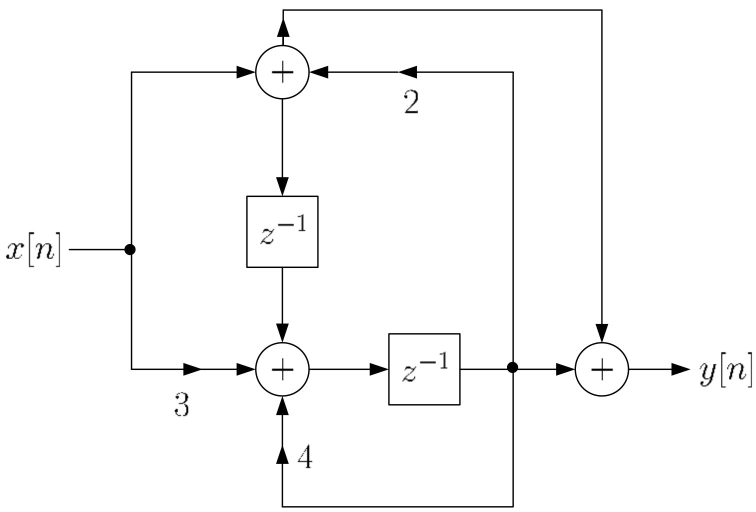


Figure 1

(a) Determine the system transfer function $H(z) = Y(z)/X(z)$ where $X(z)$ and $Y(z)$ are the $z$ transforms of the input $x[n]$ and output $y[n]$, respectively.
(b) Write down the difference equation that relates $x[n]$ and $y[n]$.
(c) Draw the block diagram representation of the system using canonic form.
(d) Is the system stable? Explain your answer.

4. Consider an ideal bandpass filter whose frequency response in $(-\pi, \pi)$ is:

$$H_d(e^{j\omega}) = \begin{cases} 1 & \omega_a \le \omega \le \omega_b, \quad -\omega_b \le \omega \le -\omega_a \\ 0 & \text{otherwise} \end{cases}$$

where $\omega_a = 0.25\pi$ and $\omega_b = 0.75\pi$.

(a) Use the window method with rectangular window to design a causal and linear-phase finite impulse response (FIR) filter of length 5 that approximates $H_d(e^{j\omega})$. Write down the filter transfer function $H(z)$ with numerical values.
(b) When implementing the FIR filter with transfer function $H(z)$, determine the minimum numbers of multiplications and additions for computing each output sample.