ICE503 DSP-Homework#2

1. For each of the following systems, determine whether the system is (1) linear, (2) time invariant, and (3) causal.

   (a) $y[n] = ax[n] + b$, a and b are non-zero constant

   (b) $y[n] = x[an + b]$, a and b are non-zero positive constant

   (c) $y[n] = \frac{1}{M}\sum_{k=0}^{M-1} x[n-k]$

   (d) $y[n] = \log_{10}(|x[n]|)$

2. The system T in Figure 1 is known to be time-invariant. When the inputs to the system are $x_1[n]$, $x_2[n]$, and $x_3[n]$, the responses of the system are $y_1[n]$, $y_2[n]$, and $y_3[n]$ as shown. Determine whether the system T is linear or nonlinear.

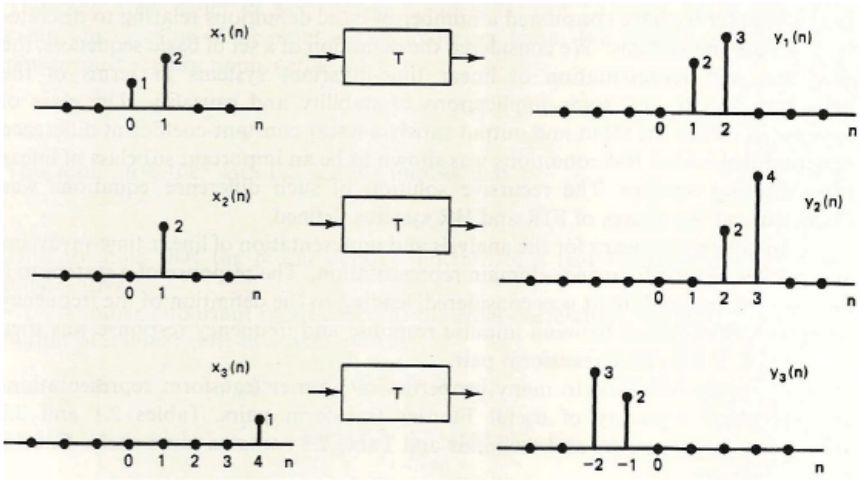

Figure 1: The time-invariant system T

3. In order to determine the impulse response of an unknown causal, linear time-invariant (LTI) system, Kai feeds the following input x[n] to the system:

   x[n] = 0, if n < 0; x[n] = 1, if n ≥ 0.

   The corresponding output y[n] is given by the following: y[n] = 0, if n < 0; y[n] = 8, 12, 14, 15, 15.5, for n = 0, 1, 2, 3, 4, respectively; y[n] = 15.75, if n ≥ 5.

   (a) Find the impulse response of this system.

   (b) Let y = [y[0],…,y[5]]^T and x=[x[0],…,x[5]]^T. The input-output relationship of this system can be written as y = **H**x, Determine the matrix **H**.

4. MATLAB simulation:

The input signal is

$$x[n] = \delta[n] + 3\delta[n-1] + 2\delta[n-2] + 6\delta[n-3] + 7\delta[n-4] + 5\delta[n-5] + 4\delta[n-6]$$

and the output signal of a 3-point moving average is

$$y[n] = \frac{1}{3}\sum_{k=0}^{2} x[n-k]$$

(a) Use stem function to plot $x[n]$.

(b) Use for loop to calculate $y[n]$.

(c) Use convolution function to calculate $y[n]$.

(The result of $y[n]$ in (b) and (c) should be the same.)

(d) Use stem function to plot y[n].