Introduction to DSP: Systems & LTI Systems - Tutorial

1. Consider the following discrte-time signal,

$$x[n] = \begin{cases} -2, & n = -2 \\ 0, & n = -1 \\ 1, & n = 0 \\ 3, & n = 1 \\ -1, & n = 2 \\ 1, & n = 0 \\ 0, & \text{Otherwise} \end{cases}$$

   Compute the followint signals.

   (a) $x\left[-n\right] = 1$

   (b) $x\left[n+3\right] = 1$

   (c) $x\left[-n+1\right]$

   (d) $x\left[-n-2\right]$

2. Find if the following systems satisfy the properties of linearity, time-invariance, causality, and stability. Compute the impulse response of the systems that are linear and time-invariant.

   (a) $y[n] = \sum_{k=0}^{\infty} x[n-k]$

   (b) $y[n] = \sum_{k=-3}^{2} x[n+k] \cdot x[n-k]$

(c) $y\,[n] = y[n-1] + 0.1 \cdot x[n]$

(d) $y\,[n] = n \cdot x[n] + (n-1) \cdot x[n-1]$

3. Compute of the output an LTI system with the following impulse response

$$h[n] = \begin{cases} 0, & n < 0 \\ 3, & n = 0 \\ 2, & n = 1 \\ 1, & n = 2 \\ 0, & n > 2 \end{cases}$$

(a) $x[n] = \delta[n] + \delta[n-3]$

(b) $x[n] = u[n]$

(c) $x[n] = \sin(0.5\pi n)\, u[n]$

(d) $x[n] = 1, \forall n$

(e) $x[n] = (0.5)^n \,, \forall n$

(f) $x[n] = (0.5)^n \, u[n], \forall n$

4. Find the zero state response, zero input response, homogenous, and particular solutions for the following system,

$$y[n] = -\frac{1}{3}y[n-1] + \frac{1}{2}\left(x[n] + x[n-1]\right); \;\; y[-1] = 2$$

for the input $x[n] = u[n]$.

What is the impulse response of the system?