Tutorial 3

Digital Signals and Systems

Exercise 1

Calculate the first eight sample values and sketch each of the following sequences:

a. $x(n) = -2\delta(n-5)$

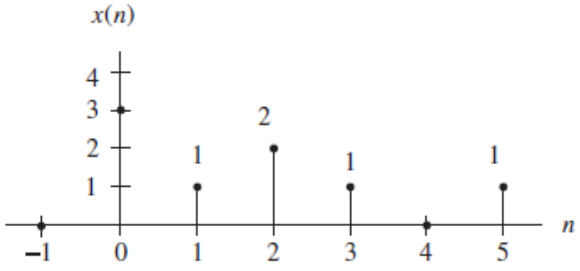
b. $x(n) = 5u(n-2)$

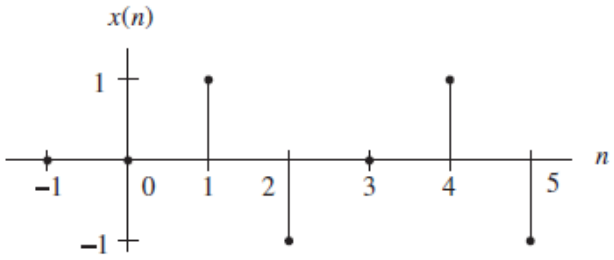
c. $x(n) = 0.5^n u(n)$

d. $x(n) = 5\sin(0.2\pi n)u(n)$

Exercise 2

Given the digital signals $x(n)$ in Figures write an expression for each digital signal using the unit-impulse sequence and its shifted sequences.





Exercise 3

Assume that a DS processor with a sampling time interval of 0.01 second converts the following analog signals $x(t)$ to a digital signal $x(n)$; determine the digital sequence for each of the analog signals.

a. $x(t) = e^{-50t}u(t)$

b. $x(t) = 5\sin(20\pi t)u(t)$

Exercise 4

Determine which of the following systems is a linear system.

a. $y(n) = 5x(n) + 2x^2(n)$
b. $y(n) = x(n-1) + 4x(n)$

Exercise 5

Determine which of the following linear systems is time invariant.

a. $y(n) = -5x(n-10)$
b. $y(n) = 4x(n^2)$

Exercise 6

Determine which of the following linear systems is causal.

a. $y(n) = 0.5x(n) + 100x(n-2) - 20x(n-10)$
b. $y(n) = x(n+4) + 0.5x(n) - 2x(n-2)$

Exercise 7

Find the unit-impulse response for each of the following linear systems.

a. $y(n) = 0.5x(n) - 0.5x(n-2)$; for $n \geq 0$, $x(-2) = 0$, $x(-1) = 0$
b. $y(n) = 0.75y(n-1) + x(n)$; for $n \geq 0$, $y(-1) = 0$

Exercise 8

Determine the stability for each of the following linear systems.

a. $y(n) = \sum_{k=0}^{\infty} 0.75^k x(n-k)$
b. $y(n) = \sum_{k=0}^{\infty} 2^k x(n-k)$

Exercise 9

Using the sequence definitions, evaluate the digital convolution

$$h(k) = \begin{cases} 2, & k = 0,1,2 \\ 1, & k = 3,4 \\ 0 & \textit{elsewhere} \end{cases} \quad \textit{and } x(k) = \begin{cases} 2, & k = 0 \\ 1, & k = 1,2 \\ 0 & \textit{elsewhere} \end{cases}$$

a. using the graphical method;

b. using the table method;

c. applying the convolution formula directly.