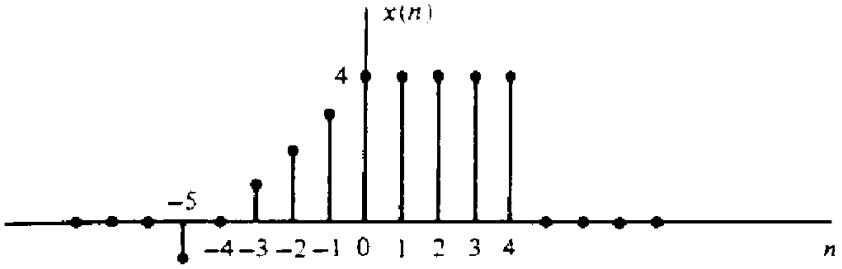
# DSP TUTORIAL 1

1. Represent the following unit step sequences graphically or sequentially:

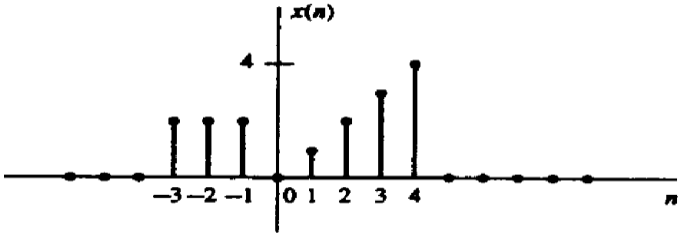
   u [n], u [n-2], u [-n], u [-n +2], u [-n -2]

2. A discrete-time signal *x [n]* is shown below draw a graphical representation of the signals x [n-3] and

   x [n+2]

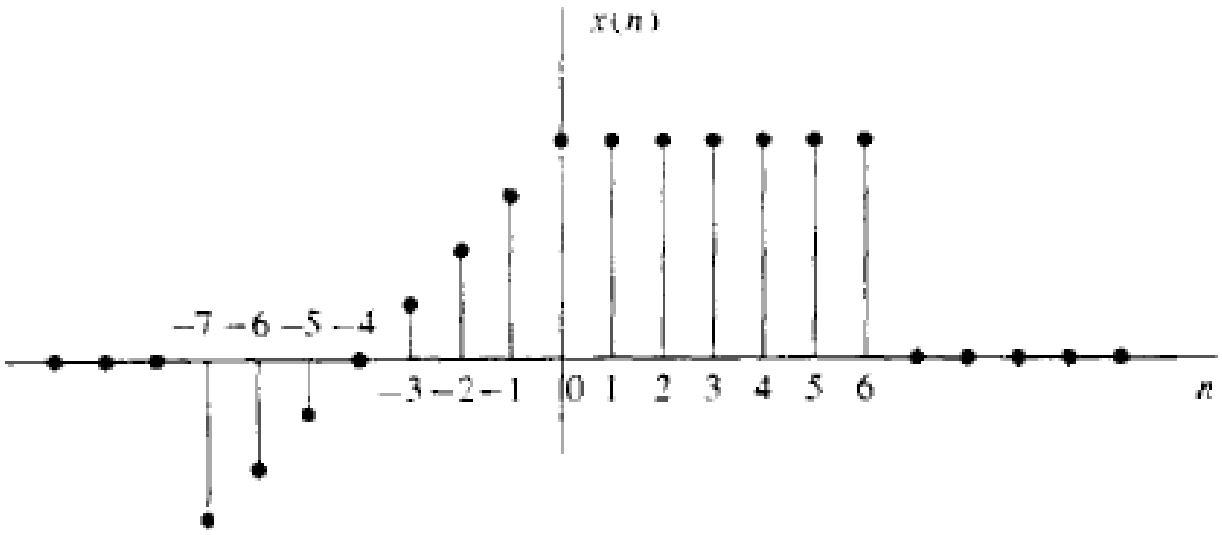



3. Show the graphical representation of the signal x [-n] and x [-n+2) where x [n] is the signal illustrated in figure below:




4. Show the graphical representation of the signal

   y [n] = x [2n] where x [n] is the signal illustrated in figure below




5. Show the graphical representation of the function g[n] = U [n] – U [n -4].
6. A discrete-time signal x [n] is defined *as*

$$x(n) = \begin{cases} 1 + \frac{n}{3}, & -3 \le n \le -1 \\ 1, & 0 \le n \le 3 \\ 0, & \text{elsewhere} \end{cases}$$

a) Determine the values in sequential and graphical representations of the signal x[n]
b) Give the sequential representations of x[-n], x[-n +4], x[-n -4]
c) Can you express the signal x[n] in terms of δ[n] and u[n]? ( in one expression)

7.

Determine the response of the following sytems to the input signal

$$x(n) = \begin{cases} |n|, & -3 \le n \le 3 \\ 0, & \text{otherwise} \end{cases}$$

**(a)** $y(n) = x(n)$

**(b)** $y(n) = x(n-1)$

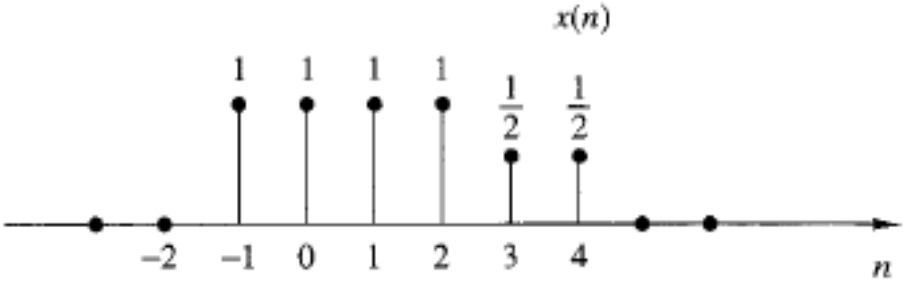
**(c)** $y(n) = x(n+1)$

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

8.A discrete-time signal *x[n])* shown in the figure below, give the sequence representation of the following signals:

*(a) x(n - 2 )* (b) x(4 - *n*) *(c) x(n + 2 )*

*( d ) x(n) u(2-n)* *(e) x(n - 1)δ(n* - 3)




9. Test whether the discrete-time signal $x[n] = \left(\frac{1}{5}\right)^n u[n]$ is a power or energy signal.

10. A system has the input-output relation given by y[n] = nx[n]. Determine whether the system is i) causal, ii) linear, iii) time-invariant.

11. Determine if the system y(n) = x(— n) is time variant or time invariant.

12. The following are the impulse responses of discrete-time LTI systems. Determine whether each system is causal. Justify your answer.

i) $$h[n] = (\frac{1}{2})^n u[n]$$

ii) $$h[n] = (0.6)^n\, u[n-2] + (0.5)^n\, u[-n]$$

13. Determine if the system described by the following input-output equation are linear or nonlinear

i.e. $$y(n) = x(n^2)$$

14. Determine whether or not the signals below are periodic, and, for each signal that is periodic, determine the fundamental period.

(i) $x[n] = \cos(0.125\,\pi n)$

(ii) $x[n] = \mathrm{Re}[e^{jn/12}] + \mathrm{Im}[e^{jn/18}]$

15. Consider a finite duration sequence given as:

$$x(n) = \{2, \underset{\uparrow}{4}, 0, 3\}$$

Resolve the sequence x(n) into a sum of weighted shifted impulses and into a sum of unit step sequences

16)

Consider the analog signal

$$x_a(t) = 3\cos 100\pi t$$

**(a)** Determine the minimum sampling rate required to avoid aliasing.

**(b)** Suppose that the signal is sampled at the rate $F_s = 200$ Hz. What is the discrete-time signal obtained after sampling?

**(c)** Suppose that the signal is sampled at the rate $F_s = 75$ Hz. What is the discrete-time signal obtained after sampling?

17)

Consider the analog signal

$x_a(t) = 3\cos 50\pi t + 10\sin 300\pi t + \cos 100\pi t$

What is the sampling frequency for this signal?