Al-Mustaqbal University College
Department of Medical Instrumentation Techniques Engineering
Class: 3rd
Subject: Digital Signal Processing
Lecturer: Dr. Rami Qays Malik
Lecture: 2- Classification Of Signals

Classification Of Signals

Continuous Time signals:

the special characteristic of analog signals is that they are continuous in amplitude and define at every time The exponential and sinusoidal signals are examples of continuous time Signals,

Discrete time signals:

the discrete time signals are obtained by time sampling of continuous time signals.

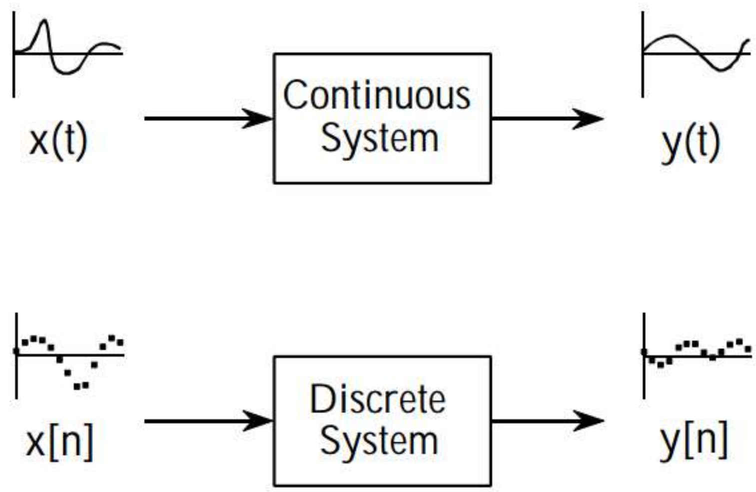


Fig 1: Continuous and Discrete System

Standard of discrete Time signals (sequences)

1- Unit sample sequences

The discrete-time counterpart for the continuous-time unit impulse (delta function) is the discrete-time unit impulse. It is defined as:

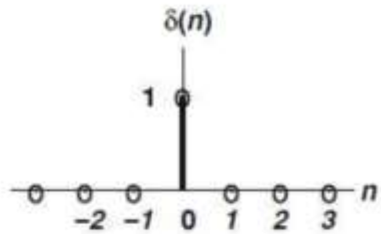
$$\delta(n) = \begin{cases} 1, & n = 0 \\ 0, & n \neq 0 \end{cases}$$

Or

$$\delta(n) = \{ \dots \dots, 0, 0, 0, \underline{1}, 0, 0, 0, \dots . \}$$

Or

$$\delta[n] = u[n] - u[n-1]$$



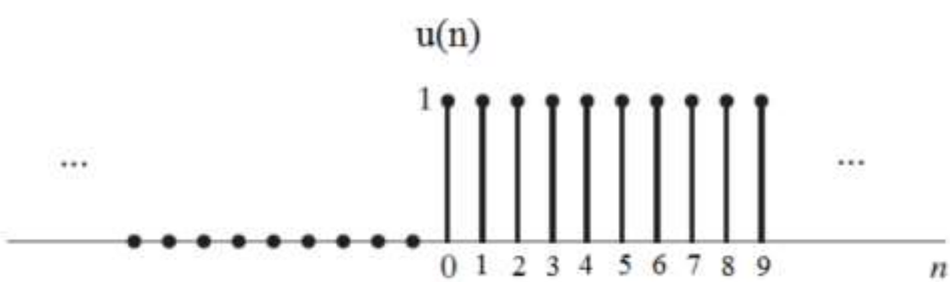
2- Unit step sequences:

The unit step sequence is one that has an amplitude of zero for negative indices and an amplitude of one for non-negative indices. Its definition is:

$$u(n) = \begin{cases} 1, & n \geq 0 \\ 0, & n < 0 \end{cases}$$

Or $u(n) = \{\dots\dots, 0, 0, \underline{1}, 1, 1, 1, 1, \dots\dots\}$

Or $u(n) = \sum_{k=0}^{\infty} \delta(n-k)$



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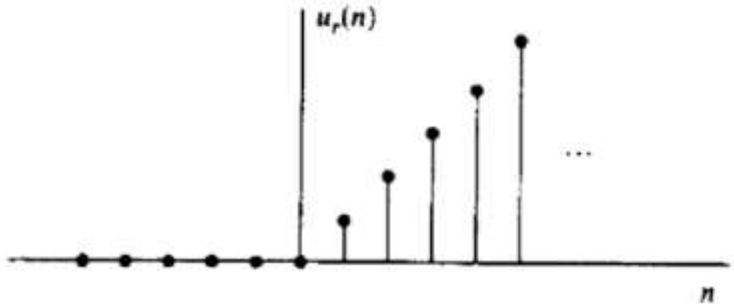
3- Ramp sequences:

It is defined by:

$$u_r(n) = \begin{cases} n, & n \geq 0 \\ 0, & n < 0 \end{cases}$$

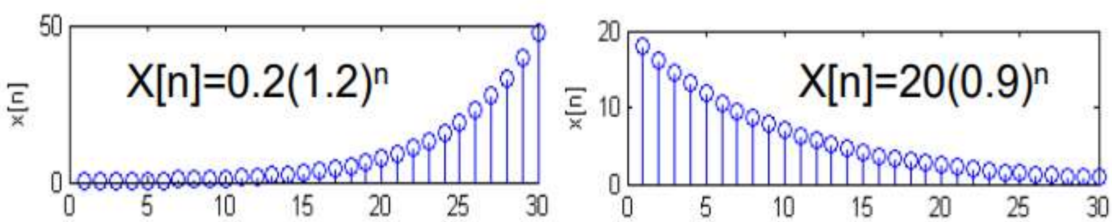


d- Exponential sequences:

Finally, an exponential sequence is defined by

$$x[n] = a^n \qquad for\ all\ \ n$$

where ***a*** may be real or complex number.



Discrete Time System

it's a device or algorithm that performs some operation on discrete time signal.

$$\underset{\text{input or excitation}}{x(n)} \longrightarrow \boxed{\text{Discrete Time System}} \longrightarrow \underset{\text{output or response}}{y(n)}$$

* the input output relationship for discrete time system is represented as:

$$y(n) = T[x(n)]$$

or

$$x(n) \xrightarrow{T} y(n)$$

* here "T" is transformation operation depends upon the characteristics of the discrete time system.

Ex:- consider the discrete time system is excited by following sequence

$$\left.\begin{aligned} x(n) &= 1 \quad \text{for } 0 \le n \le 3 \\ &= 0 \quad \text{elsewhere} \end{aligned}\right\}$$

find out the response $y(n)$ if $x(n)$ are :-

① $y(n) = x(-n)$
② $y(n) = x(n-1)$
③ $y(n) = x(n+1)$ ——→ H.W ??
④ $y(n) = x(n-1) + x(n+1)$
⑤ $y(n) = 2x(n)$ ——→ H.w ??

sol/ we will solve it graphically & analytically ..

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① $y(n) = x(-n)$:- Folding (mirroring) operation

Let us sketch the sequence $x(n)$.

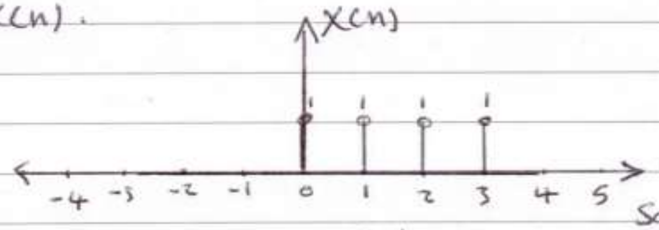

fig. graphical representation of input sequence $x(n)$

thus it is clear from above fig. that $x(n) = 1$ for $0 \le n \le 3$ and $x(n) = 0$ for $n = 4, 5, 6, \dots \infty$. Similarly $x(n) = 0$ for $n = -1, -2, -3, -4, \dots -\infty$. now we have $y(n) = x(-n)$

$n = 0 \rightarrow y(0) = x(0) = 1$
$n = 1 \rightarrow y(1) = x(-1) = 0$
$n = 2 \rightarrow y(2) = x(-2) = 0$
$n = 3 \rightarrow y(3) = x(-3) = 0$ ... and so on

Similarly
$n = -1 \rightarrow y(-1) = x(1) = 1$
$n = -2 \rightarrow y(-2) = x(2) = 1$
$n = -3 \rightarrow y(-3) = x(3) = 1$
$n = -4 \rightarrow y(-4) = x(4) = 0$ ... and so on.

Note $x(-n)$ is the mirror Image of $x(n)$

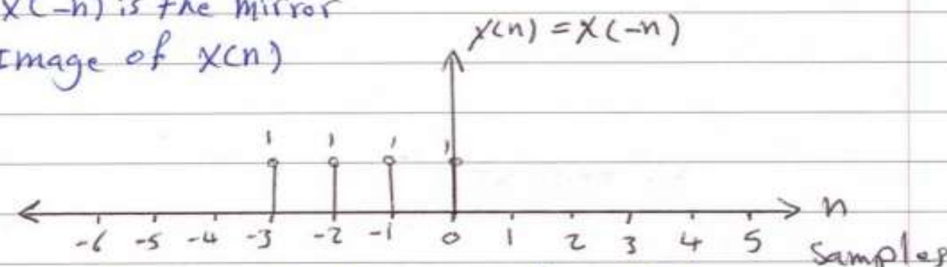

Fig. folding or reflection operation of the Sequence

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② $y(n) = x(n-1)$: Delay operation

$n=0 \rightarrow y(0) = x(0-1) = x(-1) = 0$

$n=1 \rightarrow y(1) = x(1-1) = x(0) = 1$

$n=2 \rightarrow y(2) = x(2-1) = x(1) = 1$

$n=3 \rightarrow y(3) = x(3-1) = x(2) = 1$

$n=4 \rightarrow y(4) = x(4-1) = x(3) = 1$

$n=5 \rightarrow y(5) = x(5-1) = x(4) = 0$

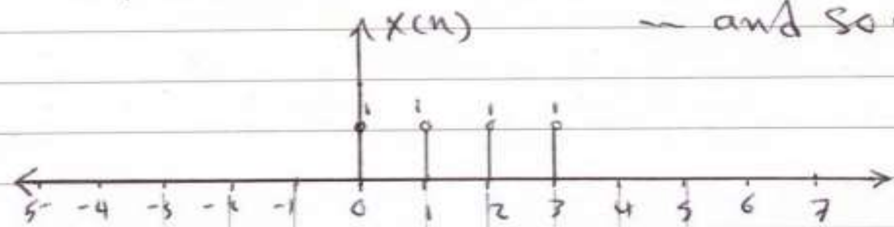
$n=6 \rightarrow y(6) = x(6-1) = x(5) = 0$ and so on

Similarly :-

$n=-1 \rightarrow y(-1) = x(-1-1) = x(-2) = 0$

$n=-2 \rightarrow y(-2) = x(-2-1) = x(-3) = 0$

.... and so on



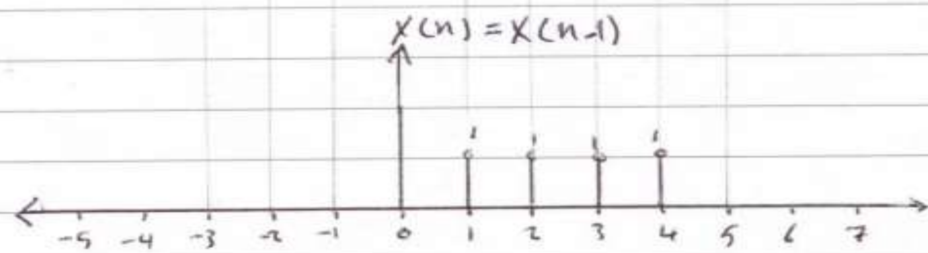


Fig. here $y(n)$ is delayed by one sample

③ $y(n) = x(n+1)$: Advancing operation

H.W ??

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(4) $y(n) = x(n-1) + x(n+1)$

Sol/

$n=0 \Rightarrow y(0) = x(0-1) + x(0+1) = x(-1) + x(1) = 1$

$n=1 \Rightarrow y(1) = x(1-1) + x(1+1) = x(0) + x(2) = 2$

$n=2 \Rightarrow y(2) = x(2-1) + x(2+1) = x(1) + x(3) = 2$

$n=3 \Rightarrow y(3) = x(3-1) + x(3+1) = x(2) + x(4) = 1$

$n=4 \Rightarrow y(4) = x(4-1) + x(4+1) = x(3) + x(5) = 1$

$n=5 \Rightarrow y(5) = x(5-1) + x(5+1) = x(4) + x(6) = 0$

$n=6 \Rightarrow y(6) = x(6-1) + x(6+1) = x(5) + x(7) = 0$

Similarly for negative values of (n) and so on

$n=-1 \Rightarrow y(-1) = x(-1-1) + x(-1+1) = x(-2) + x(0) = 1$

$n=-2 \Rightarrow y(-2) = x(-3) + x(-1) = 0$

$n=-3 \Rightarrow y(-3) = x(-4) + x(-2) = 0$ and so on

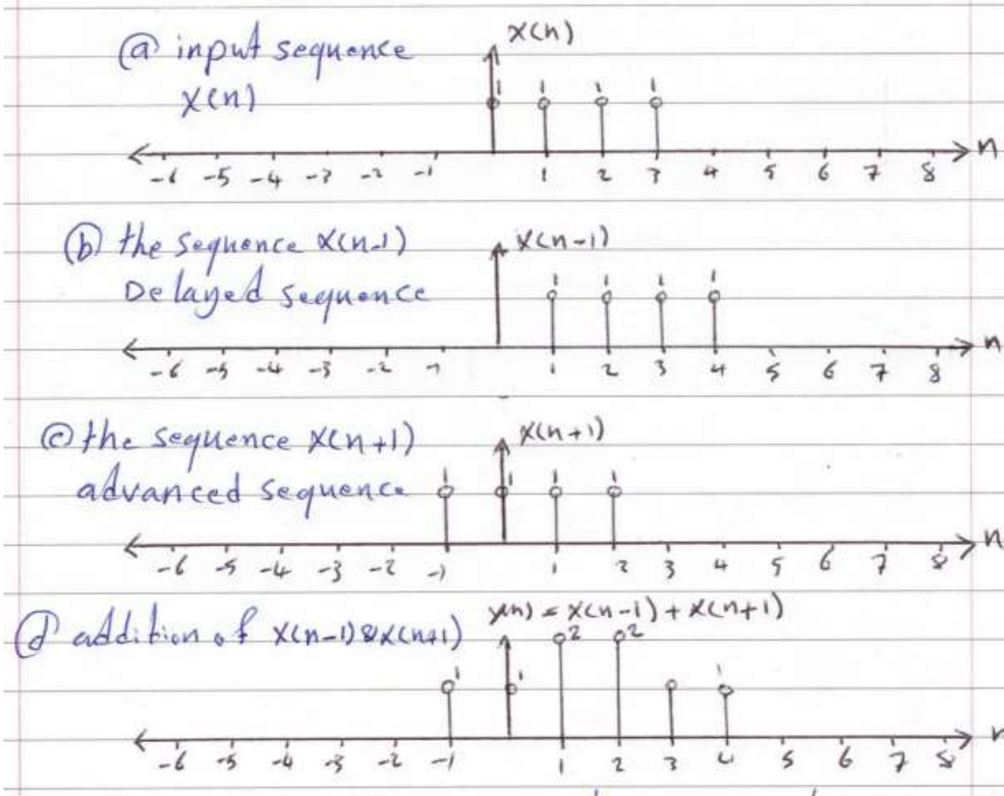

Fig. Addition operation in discrete time Sys.