BASICS OF SIGNALS

Signal

- Signal is mathematical representation of physical phenomenon, which contains some information.

PHYSICAL PHENOMENON: AC VOLTAGE

MATHEMATICAL REP: $x(t) = A\cos\omega t$ → Signal

Frequency

Amplitude

Signal

- Signal is dependent variable, which depends on, one or more independent variables.

1. $x(t)$
   - DV = $x(t)$
   - IDV = t : continuous time
   - Continuous Time Domain Signal

2. $x[n]$
   - DV = $x(n)$
   - IDV = n : Discrete Time
   - Discrete Time Domain Signal

CLASSIFICATION OF SIGNALS

- Continuous Time Signal & Discrete Time Signal
- EVEN & ODD
- EVEN CONJUGATE & ODD CONJUGATE
- PERIODIC & NON PERIODIC
- ORTHOGONAL & NON ORTHOGONAL
- ENERGY & POWER

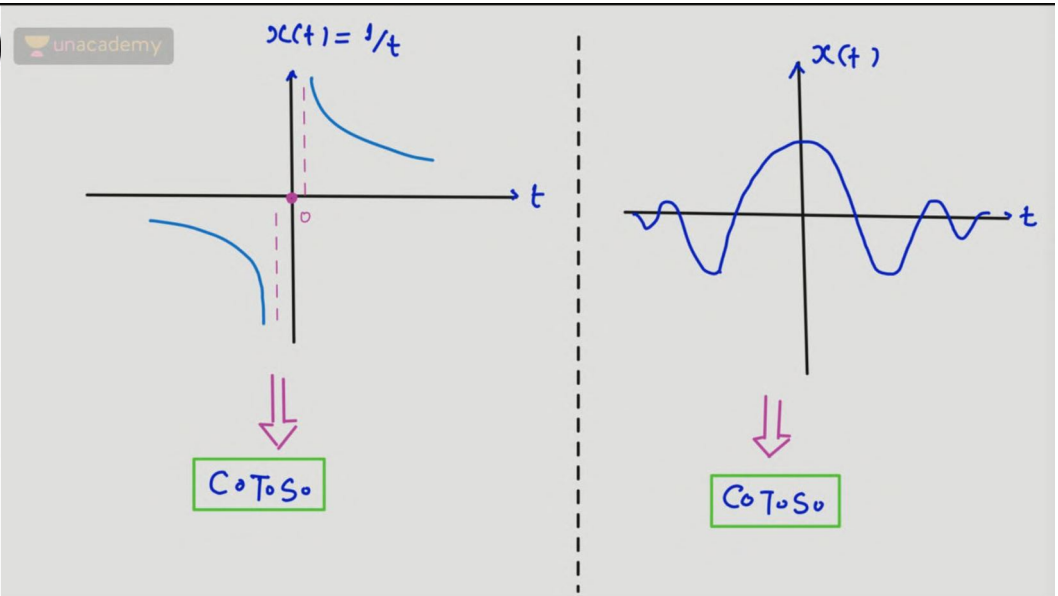
CLASSIFICATION OF SIGNALS

- CAUSAL & NON CAUSAL
- BOUNDED & UNBOUNDED
- ABSOLUTELY INTEGRABLE/ ABSOLUTELY SUMMABLE
- ANALOG & DIGITAL
- LEFT SIDED, RIGHT SIDED, BOTH SIDED

C.T.S. and D.T.S.

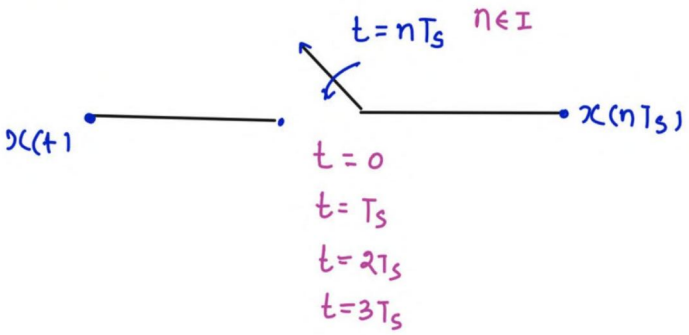
Continuous Signal

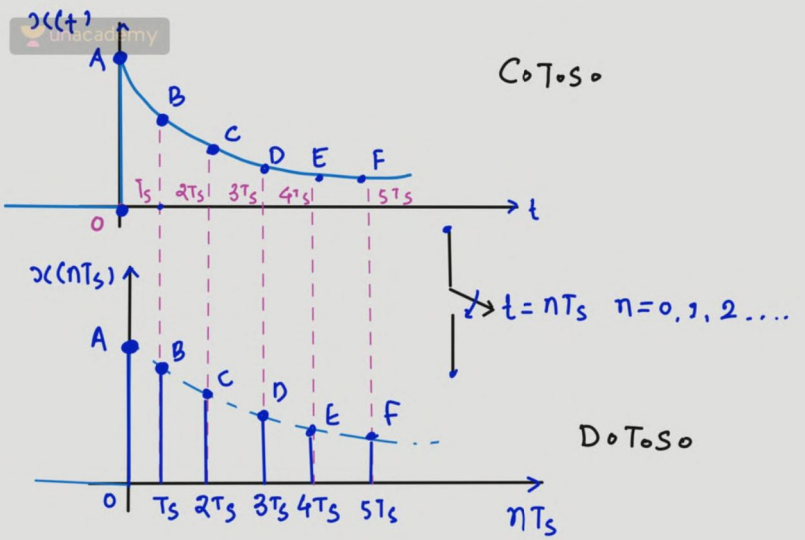
- Continuity in Amplitude → LHL = RHL = f(a) → finite
- Continuity in Time → Independent variable = t



D.T.S.

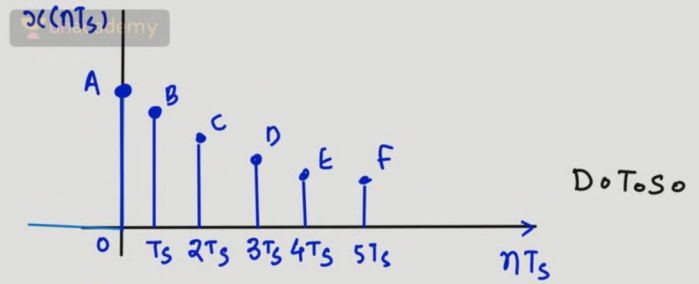
- DTS are obtained from CTS by a process called as **UNIFORM SAMPLING.**

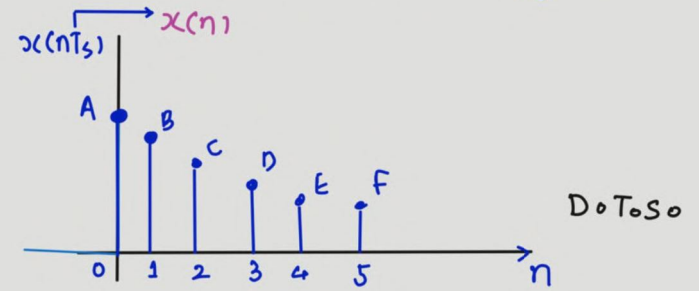




T_s = Sampling Interval

$\frac{1}{T_s} = f_s$ = Sampling Frequency or sampling RATE





MATHEMATICAL CONVERSION

GIVEN $x(t) = f(t) : a \le t \le b$ FIND D.T.S.

S·1 Find out T_s

S·2 put $t = nT_s$ in $\longrightarrow$ $x(t) = f(t) : a \le t \le b$

$x(nT_s) = f(nT_s) : a \le nT_s \le b$

(put T_s ↓ put T_s)

$$x(n) = f(nT_s) : \frac{a}{T_s} \le n \le \frac{b}{T_s}$$

Q. $x(t) = \sin(200\pi t)$ Find D.T.S. if $f_s = 10$ Hz.

S·1 $T_s = \frac{1}{f_s} = 0.1$ sec

S·2 $t = nT_s$

$x(nT_s) = \sin(200\pi nT_s)$

$x(n) = \sin(200\pi n \times 0.1)$

$x(n) = \sin(20\pi n)$ $n \in I$

Q. $x(t) = \frac{1}{2}e^{-0.5t}$ Find DTS if $f_s = 20$ Hz

S·1 $T_s = \frac{1}{20}$ sec

S·2 $x(nT_s) = \frac{1}{2}e^{-0.5nT_s}$

$x(n) = \frac{1}{2}e^{-\frac{0.5n}{20}} = \frac{1}{2}e^{-0.025n}$ $n \in I$

Q. $x(t) = \begin{cases} 1 - |t| & : |t| \le 4 \\ 0 & : \text{else} \end{cases}$

Find DTS. if $T_s = 2$ sec

S·1 $T_s = 2$ sec

S·2 $x(nT_s) = \begin{cases} 1 - |nT_s| & : |nT_s| \le 4 \\ 0 & : \text{else} \end{cases}$

$$x(nT_s) = \begin{cases} 1 - |nT_s| & : |nT_s| \le 4 \\ 0 & : \text{else} \end{cases}$$

$$x(n) = \begin{cases} 1 - |2n| & : |2n| \le 4 \\ 0 & : \text{else} \end{cases}$$

$$x(n) = \begin{cases} 1 - 2|n| & : 2|n| \le 4 \\ 0 & : \text{else} \end{cases}$$

$$x(n) = \begin{cases} 1 - 2|n| & : |n| \le 2 \\ 0 & : \text{else} \end{cases}$$

NOTE $|x| \le a \longrightarrow -a \le x \le a$

$$x(n) = \begin{cases} 1 - 2|n| & : |n| \le 2 \\ 0 & : \text{else} \end{cases} \quad n \in I$$

$$= \begin{cases} 1 - 2|n| & : -2 \le n \le 2 \\ 0 & : \text{else} \end{cases}$$

$$x(n) = \begin{cases} 1 - 2|n| & : n = -2, -1, 0, 1, 2 \\ 0 & : \text{else} \end{cases}$$

$n = -2 \longrightarrow x(-2) = -3$

$n = -1 \longrightarrow x(-1) = -1$

$n = 0 \longrightarrow x(0) = 1$

$n = 1 \longrightarrow x(1) = -1$

$n = 2 \longrightarrow x(2) = -3$

GRAPHICAL REP.

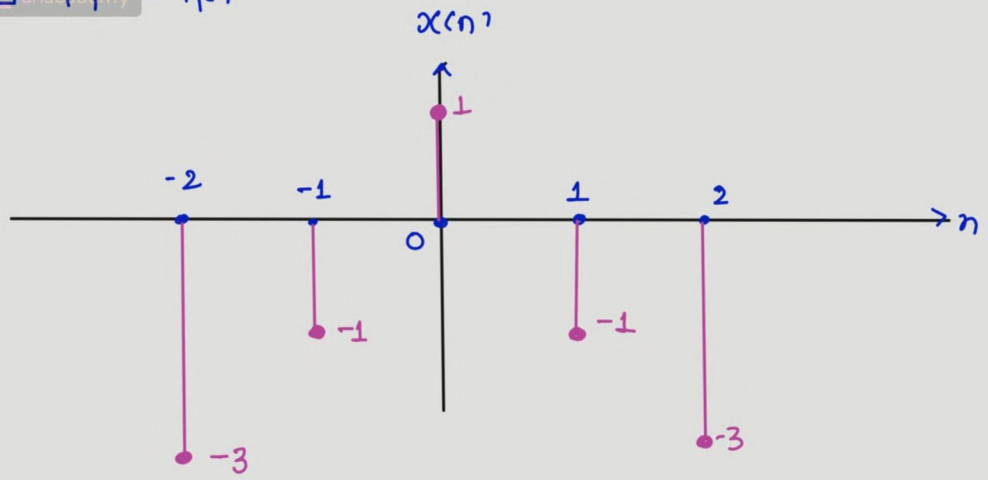
SEQUENCE REP.

1 SEQUENCE REP.

$$x(n) = \{-3, -1, \underset{\uparrow}{1}, -1, -3\}$$

$n=-2$ $n=-1$ $n=0$ $n=1$ $n=2$

2. GRAPH REP



Q.

$$x(t) = \begin{cases} 1 - \frac{|t|}{4} & : \ |t| \le 4 \\ 0 & : \ \text{else} \end{cases}$$

Calculate DTS if $f_s = 0.25$ Hz

S-1 $T_s = \frac{1}{f_s} = 4\text{sec}$

S-2 $x(nT_s) = \begin{cases} 1 - \frac{|nT_s|}{4} & : \ |nT_s| \le 4 \\ 0 & : \ \text{else} \end{cases}$

$x(n) = \begin{cases} 1 - |n| & : \ |4n| \le 4 \\ 0 & : \ \text{else} \end{cases}$

$x(n) = \begin{cases} 1 - |n| & : \ |n| \le 1 = -1 \le n \le 1 : n = -1, 0, 1 \\ 0 & : \ \text{else} \end{cases}$

$x(n) = \{0, \underset{\uparrow}{1}, 0\}$, $n = 0$

Continuous Time Signals

Operations on C.T.S.

- Operations on D.V.
- Operations on I.D.V.

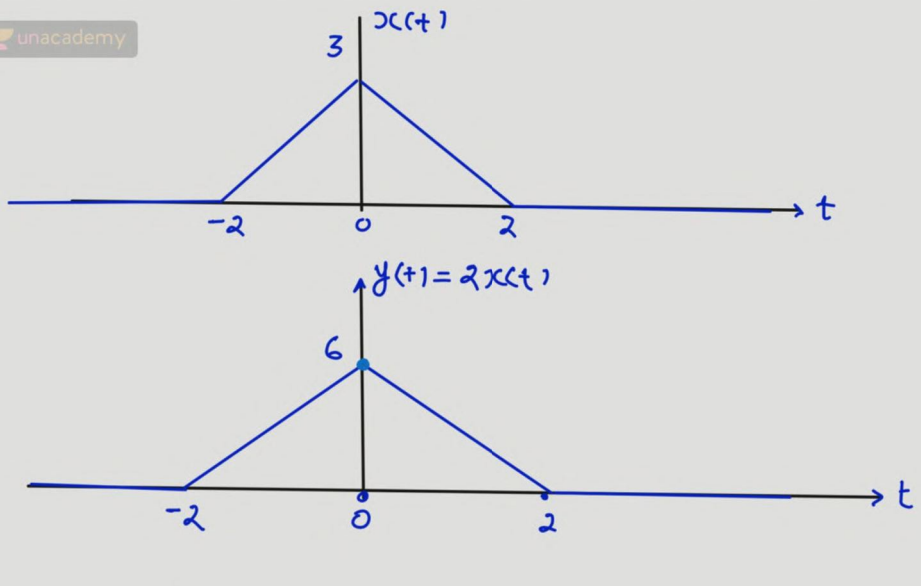
Operations on D.V.

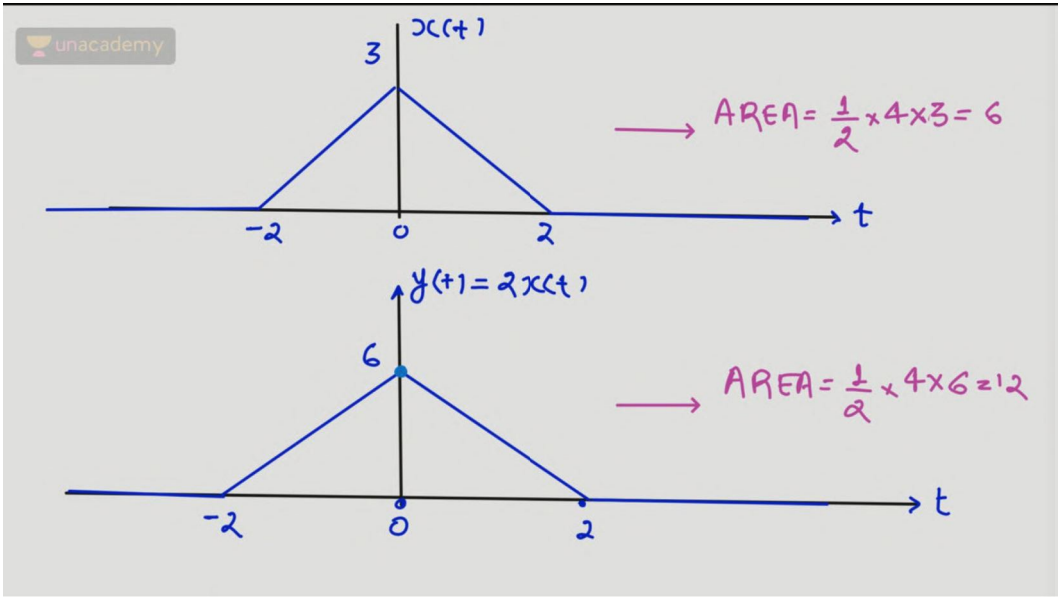
1. Amplitude Scaling

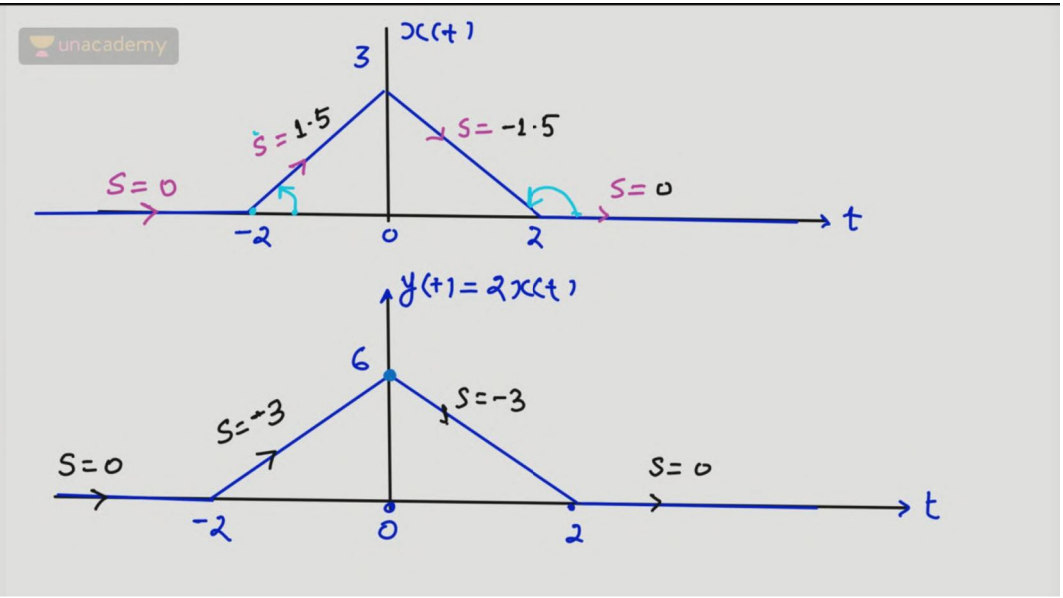
Given: x(t) vs t

Plot: Ax(t) vs t

PROCESS multiply vertical axis parameters by A.







Note

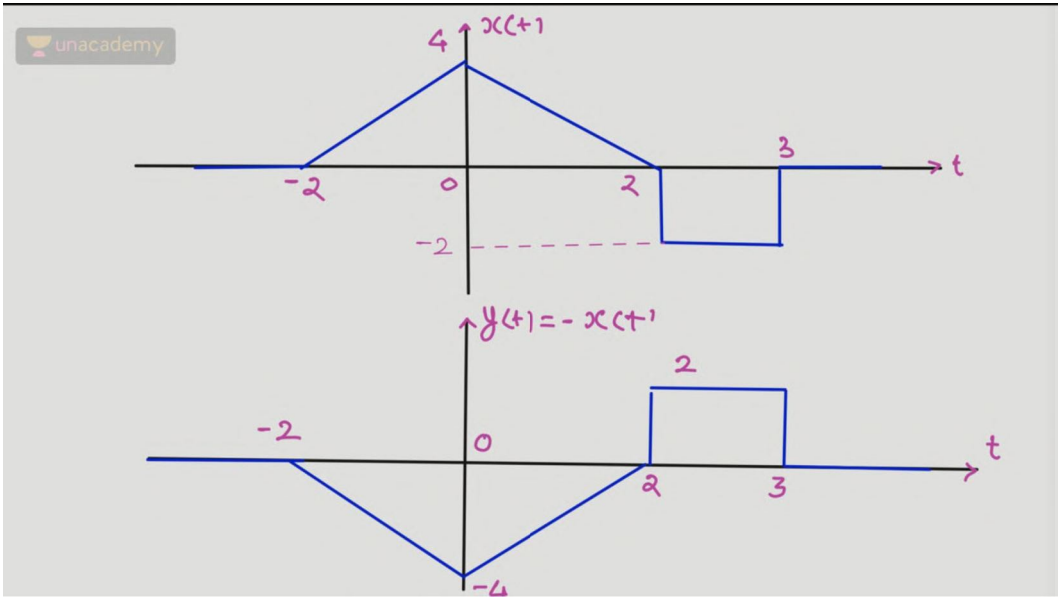
x(t) vs t	Ax(t) vs t
S = Δ	S = AΔ
Area = K	Area = AK

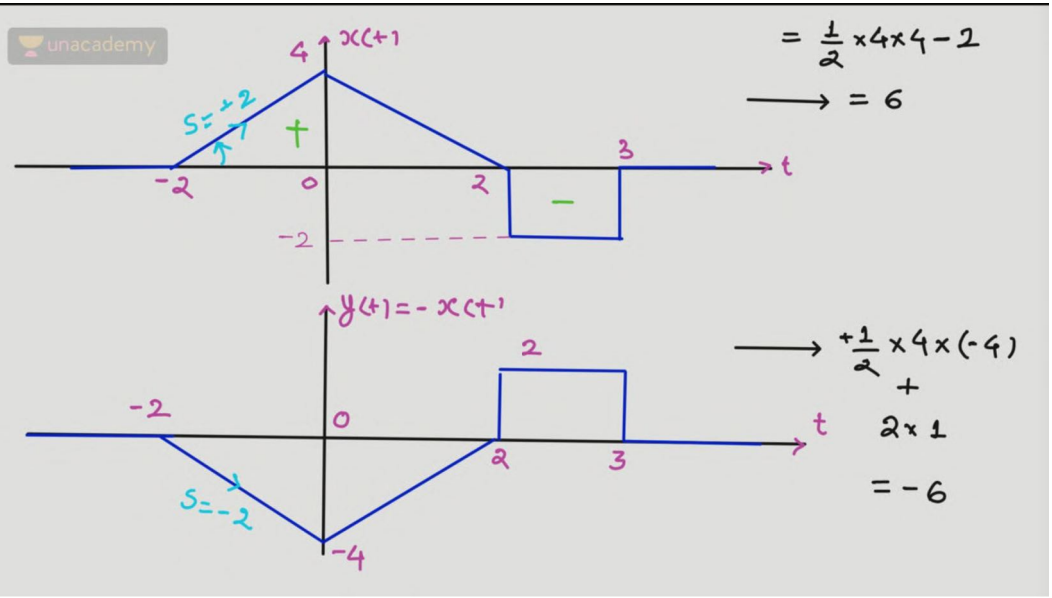
2. Amplitude Reversal

Given: x(t) vs t

Plot: – x(t) vs t

PROCESS mirror image of x(t) w.r.t. Horizontal Axis.





x(t) vs t	-x(t) vs t
S = Δ	S = -Δ
Area = K	Area = -K

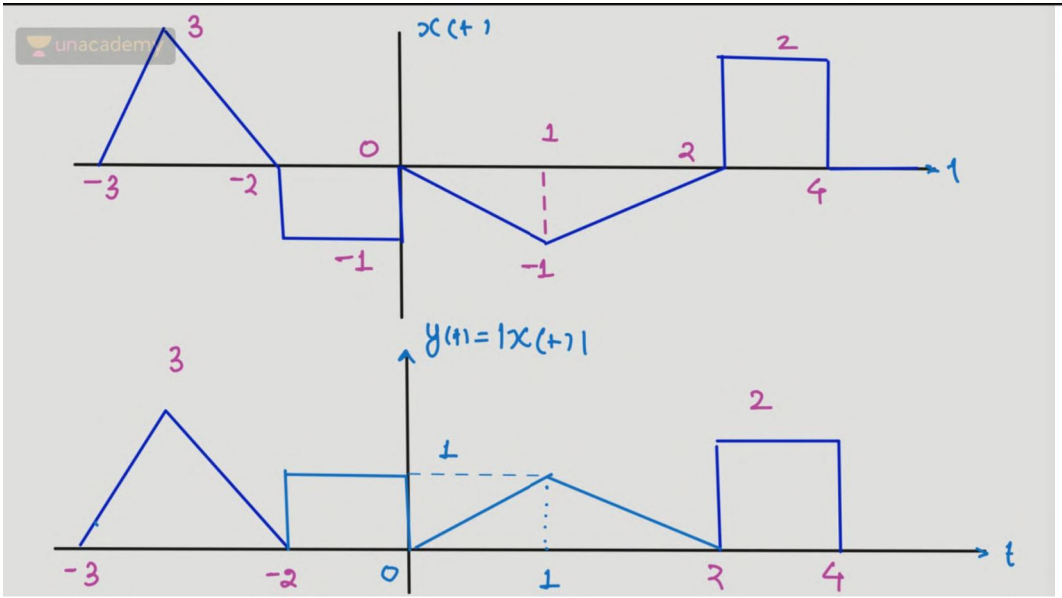
3. Modulus operation

Given: x(t) vs t

Plot: |x(t)| vs t

PROCESS

- GRAPH ABOVE HORIZONTAL AXIS: Keep As it is
- GRAPH BELOW HORIZONTAL AXIS: Mirror image w.r.t. Horizontal Axis.



4. Addition or Subtraction of dc value

Given: x(t) vs t

Plot: x(t) +A vs t

x(t) –A vs t

PROCESS (x(t) + A) vs t → Shift x(t) Graph A unit upwards.

(x(t) – A) vs t → Shift x(t) Graph A unit downwards.