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Signal System

Hand Notes For GATE, IES, PSUs etc…

Hand Notes

Page Length : 157

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Signal & System

DATE-09/10/14

Syllabus →

(1.) Signal definations & its classifications.

(2.) Different operation on signal.

- (a.) Shifting
- (b.) Scaling
- (c.) Reversal
- (d.) Differentiation
- (e.) Integration
- (f.) Convolution.

(3.) Basic system operations.

- (a.) Static/dynamic
- (b.) linear/non-linear
- (c.) Causal/Non-causal
- (d.) Time invarient/time-varient
- (e.) Stable/Unstable.

(4.) Contineous time fourier series
(5.) Contineous time fourier Xform
→ contineous time sig & sys.

(6.) Laplace Xform.

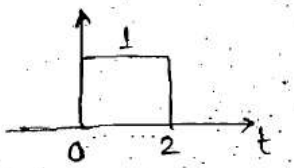
(7.) Sampling theorem
(8.) Discrete time sys.
(9.) Z-transfom
→ discrete time sig & sys.

* Different operations on signal →

* Amplitude shifting
* Time shifting
* Time scaling
* Time reversal
* Amplitude Reversal
*

(1.) Time shifting →

$x(t) \longrightarrow y(t) = x(t+k)$

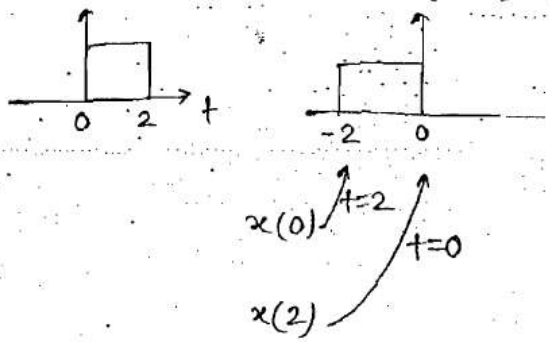


Case(1)

When $k>0$

Eg:- $k=2$

$x(t) \longrightarrow y(t) = x(t+2)$



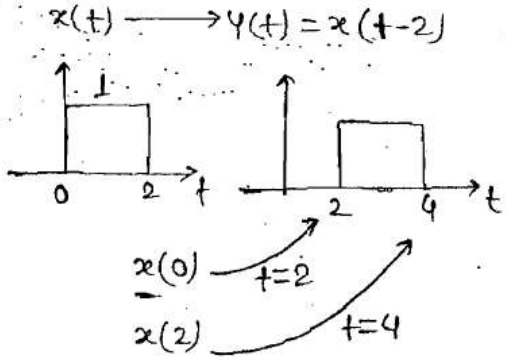
* It is a case of left shifting.

Case(2)

When $k<0$

Eg:- $k=-2$

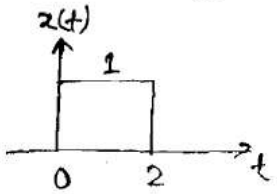
$x(t) \longrightarrow y(t) = x(t-2)$



* It is a case of right shifting

(2.) Amplitude shifting →

$x(t) \longrightarrow y(t) = k + x(t)$



$$x(t) = \begin{cases} 0 & , t<0 \\ & \end{cases}$$

Case(1) → When $k<0$

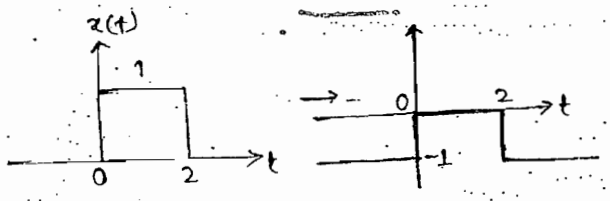
Eg:- $k=-1$

$x(t) \longrightarrow y(t) = -1+x(t)$

$y(t) = -1+x(t)$

$$= \begin{cases} -1+0 & , t<0 \\ -1+1 & ; 0\le t\le 2 \\ -1+0 & ; t>2 \end{cases}$$

$$= \begin{cases} -1 & , t<0 \\ 0 & ; 0\le t\le 2 \\ -1 & ; t>2 \end{cases}$$



* It is a case of downward shifting

Case(2) → When $k>0$

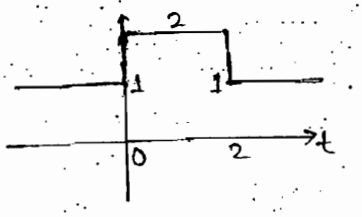
Eg:- $k=+1$

$x(t) \longrightarrow y(t) = 1+x(t)$

$y(t) = 1+x(t)$

$$= \begin{cases} 1+0 & , t<0 \\ 1+1 & ; 0<t\le 2 \\ 1+0 & ; t>2 \end{cases}$$

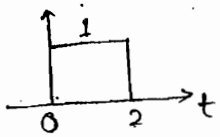
$$= \begin{cases} 1 & ; t<0 \\ 2 & ; 0\le t\le 2 \\ 1 & ; t>2 \end{cases}$$



* It is a case of upward shifting

(3.) Time Scaling →

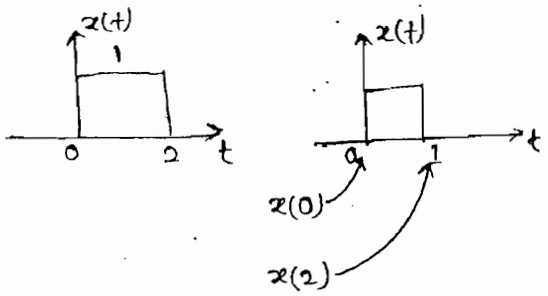
$x(t) \longrightarrow y(t) = x(at)$



Case(1) → When $a>1$

Eg:- $a=2$

$x(t) = y(t) = x(2t)$

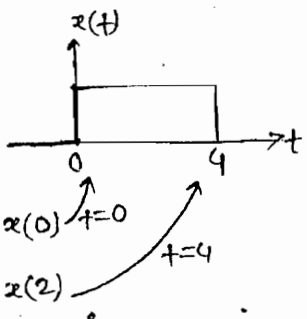


Time Compression

Case(2) → When $a<1$

Eg:- $a=0.5$

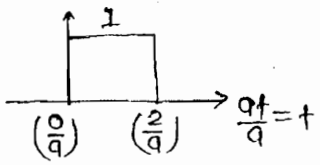
$x(t) = y(t) = x(0.5t)$



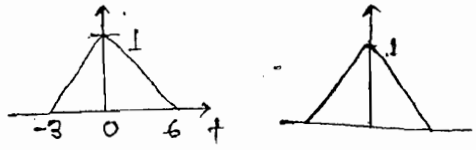
Time expansion

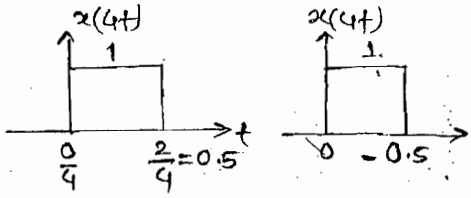
Rule General →

$x(at) \longrightarrow t$



Ex:- $x(t) \longrightarrow x(-3t)$



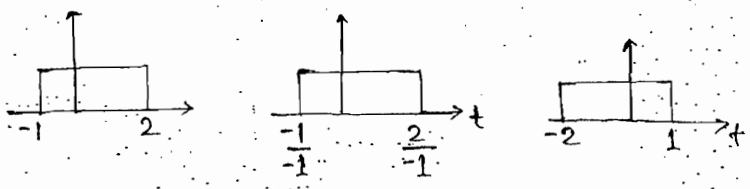


(4.) Time-reversal →

$$x(t) = y(t) = x(-t)$$

* Time reversal is a special case of time scaling in which signal folding will take palce around y-axis.

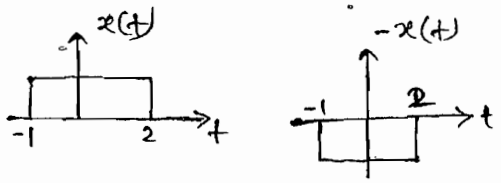
$x(-t) = a(=-1)$



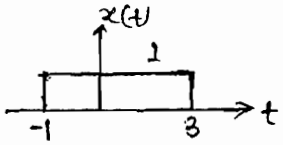
(5.) Amplitude Reversal →

$$x(t) \longrightarrow y(t) = -x(t)$$

* In this case, signal folding will take place about x-axis



Q.→



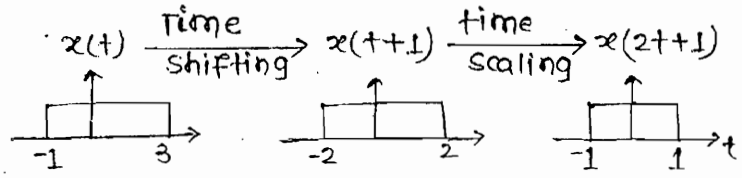
Draw signal $y(t)$ if $y(t) = 2x(2t+1)$

Soln → 1st method →

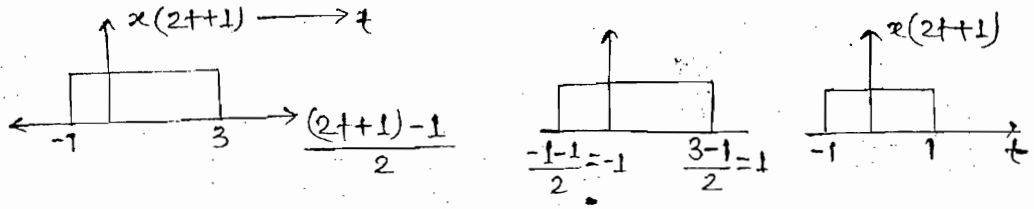
$$x(t) \xrightarrow[\text{Scaling}]{\text{time}} x(2t) \xrightarrow[\text{Shifting}]{\text{time}} x[2(t+0.5)]$$

$\uparrow 1 \qquad \uparrow \qquad \uparrow y(t)$

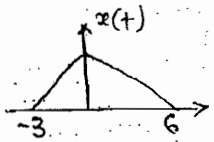
2nd method →



3rd method → (Trick)



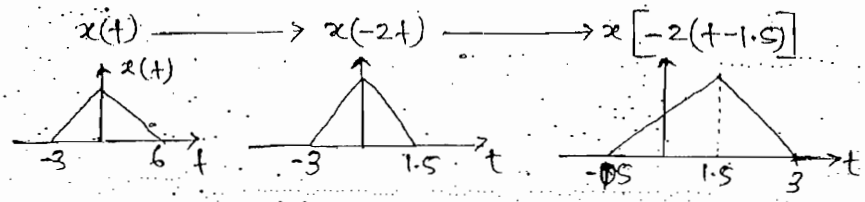
Q. →



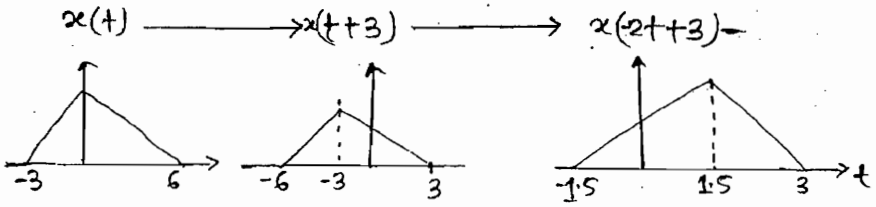
draw sig y(t) if y(t) = x(-2t+3)

Soln → 2nd method →

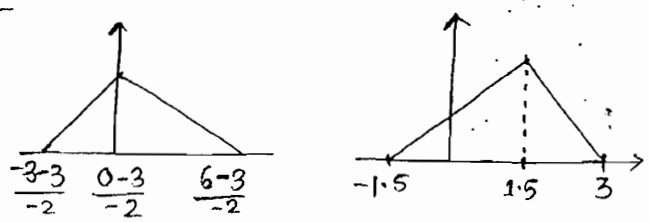
$$y(t) = x[-2(t-1.5)]$$



2nd method →



3rd method →



Chapter-01
Signal defination & Classifications

Signal → A signal is a f^n which contains some information.

System → A sys. is interconnection of devices (or) componants which converts signal from one form to another form.

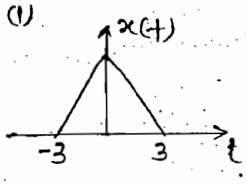
Classification of signals →

1) Even & odd signals →

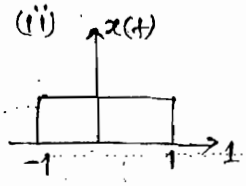
* **Even →** This are **symmetrical** (or) **mirror image** about y-axis.

i.e. → $\boxed{x(t) = x(-t)}$ → time reversal

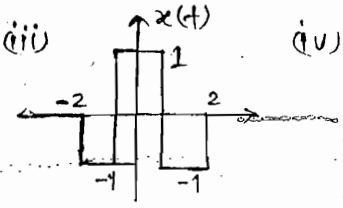
Eg:- (i)



(ii)



(iii)



(iv) $x(t) = \cos\omega_0 t$ (Even)

$t = -t$

$x(-t) = \cos\omega_0(-t)$

$= \cos\omega_0 t$

$x(-t) = x(t)$

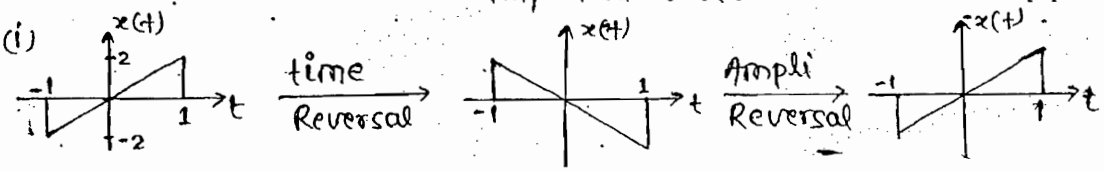
* **Odd →** This are **antisymmetrical** about y-axis.

i.e. $\boxed{x(-t) = -x(t)}$ (or) $\boxed{x(t) = -x(-t)}$

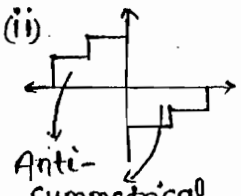
time reversal

amplitude reversal

Eg:- (i)



(ii)



(iii) $x(t) = \sin\omega t \rightarrow$ odd signal.

$(t = -t)$

$x(-t) = \sin\omega_0(-t)$

$x(-t) = -\sin\omega_0 t$

$\boxed{x(-t) = -x(t)}$

* The avg. value of an odd signal is 0; but converse of this statement is not true.

Important points →

Important points →

(1.) Even × Even = Even ; $t^2 \times t^4 = t^6$

(2.) Even × odd = odd ; $t^2 \times t^3 = t^5$

(3.) Odd × odd = Even ; $t^3 \times t^5 = t^8$

(4.) Even ± Even = Even

$x(t) = t^2 + \cos t$

$x(-t) = t^2 + \cos t = x(t)$

(5.) Odd + Odd = Odd

$x(t) = \sin t + t^3$

$x(-t) = -\sin t - t^3$

$\boxed{x(t) = -x(t)}$

(6.) Even + odd = Neither even nor odd.

$x(t) = t^2 + \sin t$

$x(-t) = t^2 - \sin t$

$\boxed{x(-t) \neq x(t)}$

* Any signal can be devided into 2 part in which one part will be even & the other part will be odd.

i.e. $\boxed{x(t) = xE(t) + xO(t)}$

where;

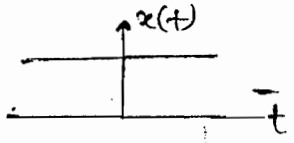
$xE(t)$ = even part of $x(t) = \dfrac{x(t) + x(-t)}{2}$

$xO(t)$ = Odd part of $x(t) = \dfrac{x(t) - x(-t)}{2}$

Eg.→ $x(t) = 2$ = dc signal

↓ $t = -t$

$x(-t) = 2 = x(t)$ [Even signal]



dc signal is a Even signal.

(2.) $f(k) = \sin(k^2)$

↓ $k = -k$

$f(-k) = \sin(k^2) = f(k)$ [Even signal]

(3.) $f(\theta) = \sin \pi/2$

$= 1$

$f(\theta) = f(-\theta)$ [Even signal]