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MADE EASY
ELECTRICAL ENGINEERING
Signal & System
By. Rohit Tripathi Sir

- Theory
- Explanation
- Derivation
- Example
- Shortcuts
- Previous Years Question With Solution

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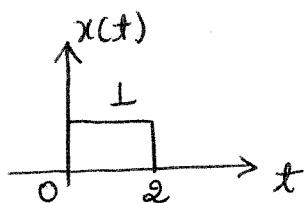
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-: SIGNAL SYSTEM :-

Different operations on signal :

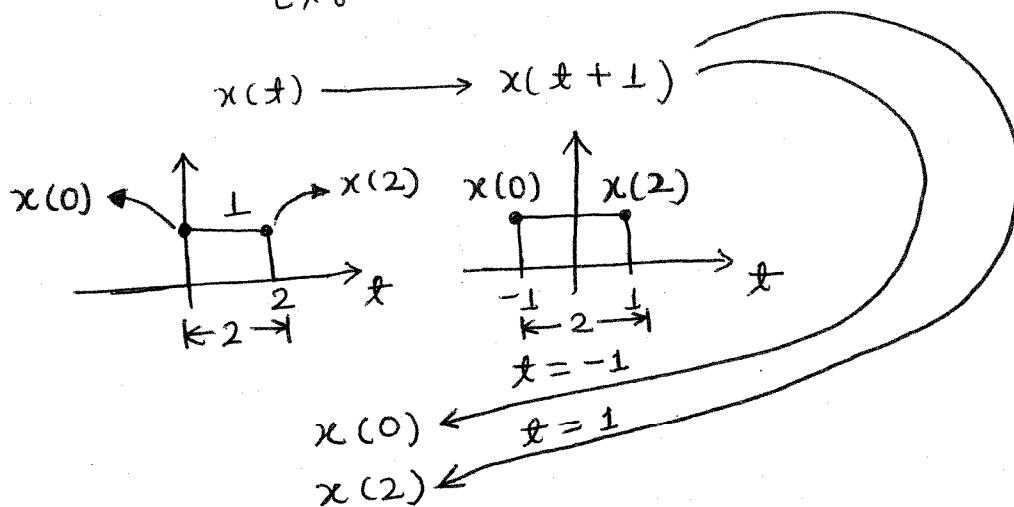
1. Time shifting :

(a) left shifting (b) Right shifting

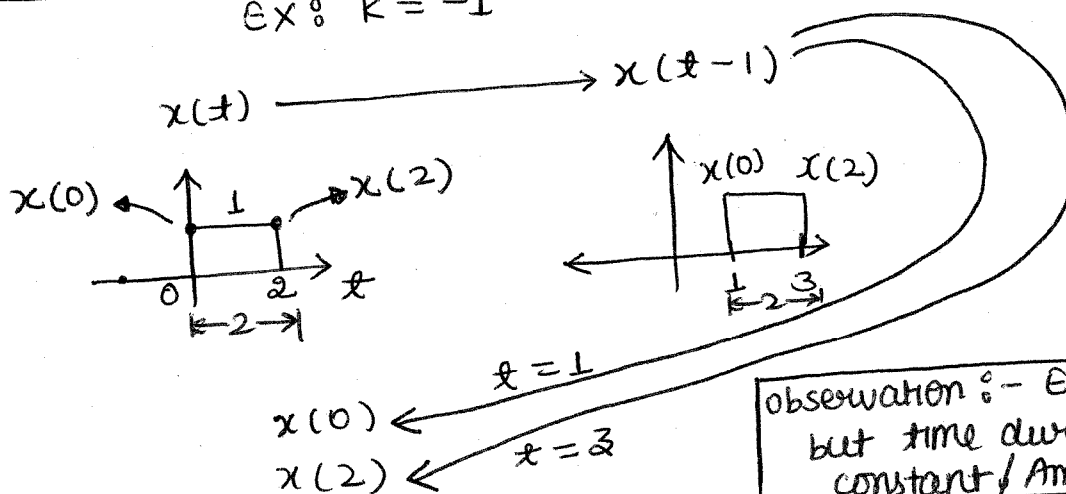


$\longrightarrow x(t+k)$
where k is a real constant.

case - (i) : when $k > 0 \rightarrow$ left shifting
EX: $k = 1$



case - ii : when $k < 0 \rightarrow$ Right - shifting
EX: $k = -1$

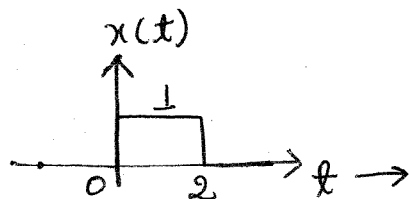


observation :- Extension get changed but time duration remains constant / Amplitude also.

2. Time - scaling :

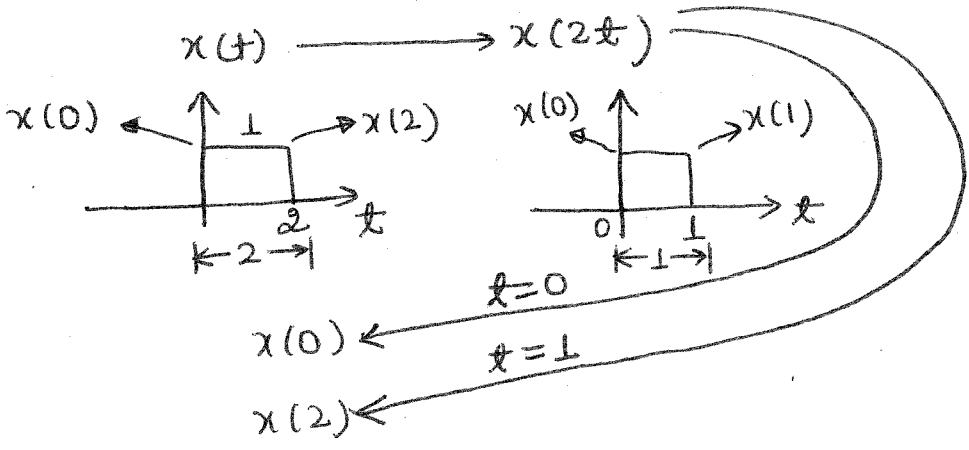
$x(t) \longrightarrow x(at), a \neq 0$

and 'a' is real constant



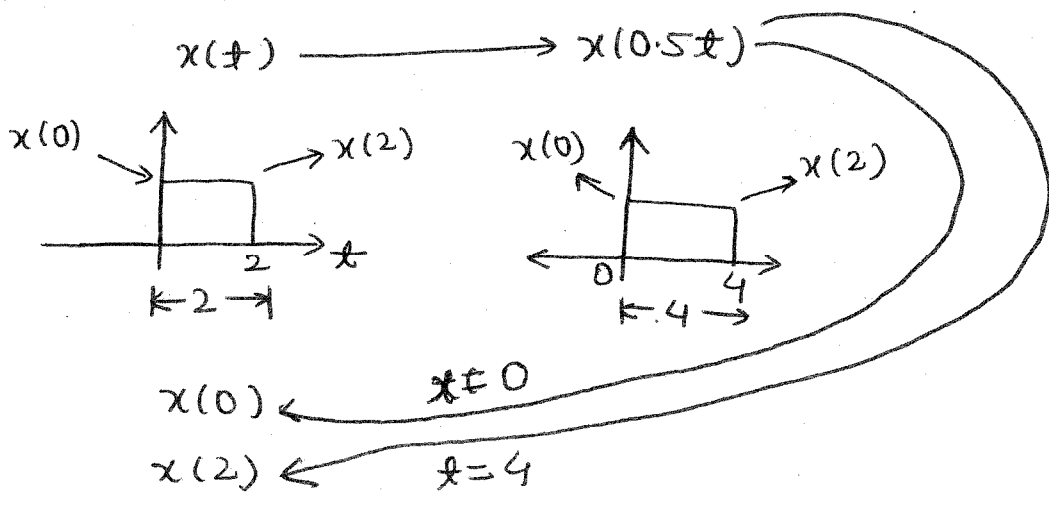
Case (i) : when $a > 1 \rightarrow$ Time compression

Ex : $a = 2$

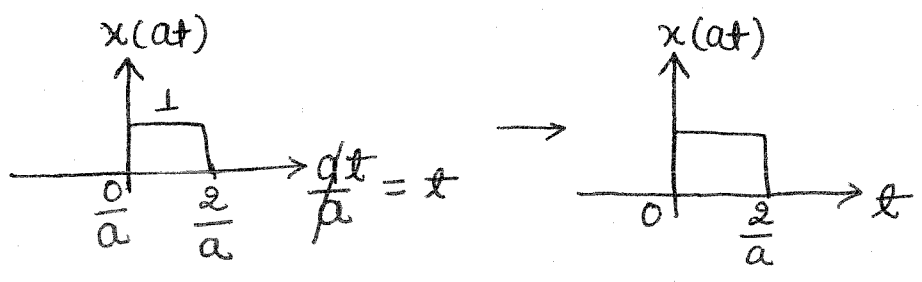


Case (ii) : when $0 < a < 1 \rightarrow$ Time expansion

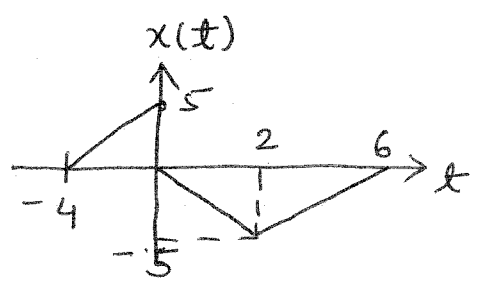
Ex : $a = 0.5$



General rule : $x(t) \rightarrow x(at)$ w.r.t variable t by default

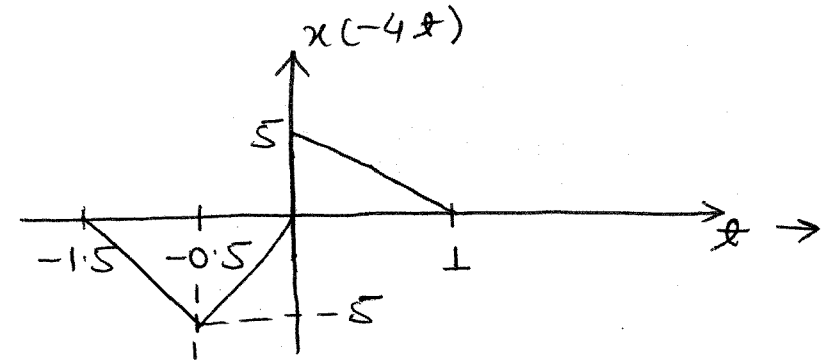
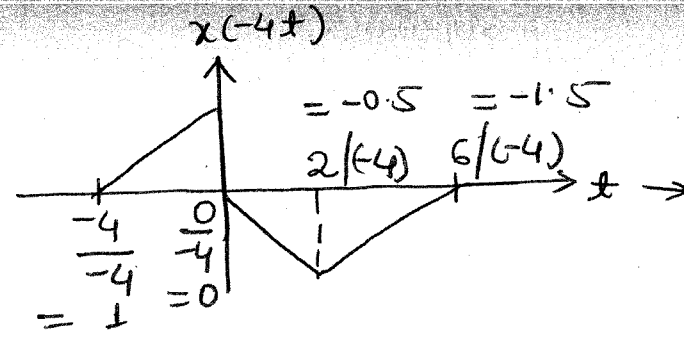


EX-:



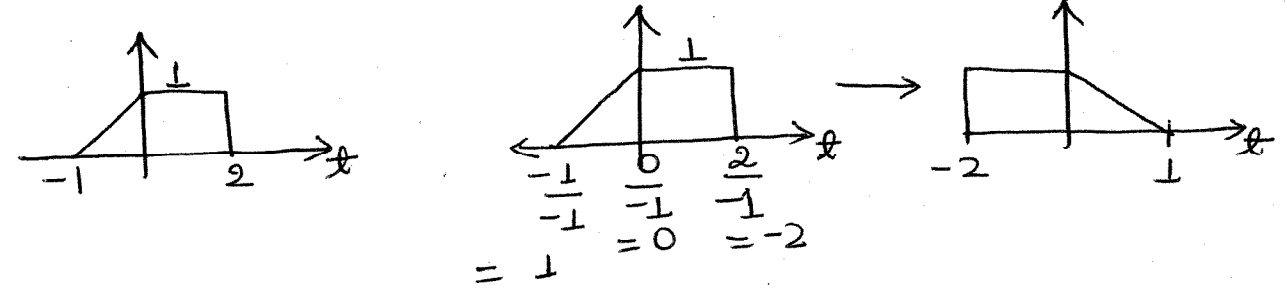
Draw waveform of signal $y(t) = x(-4t)$

Solution :-



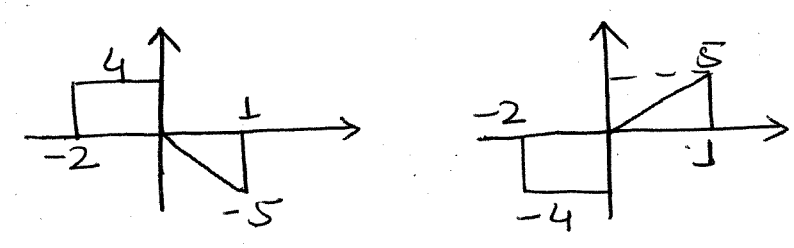
3). Time Reversal : Folding about y-axis
 $a = -1$

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

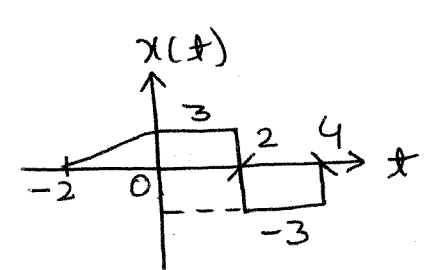


4). Amplitude Reversal : Folding about x-axis

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

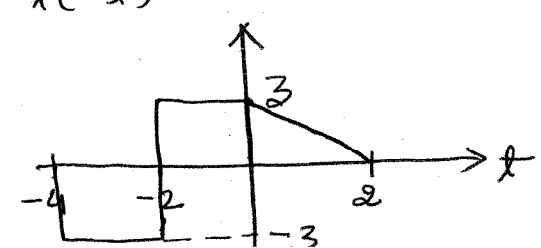


Q.N-3

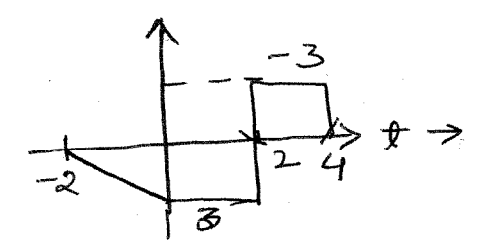


Draw (i) $x(-t)$
(ii) $-x(t)$

(i) $x(-t)$

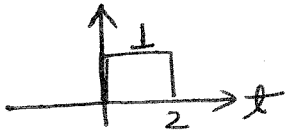


(ii) $-x(t)$



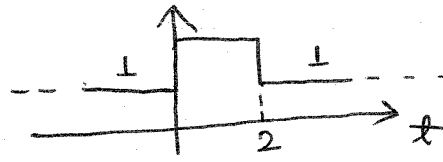
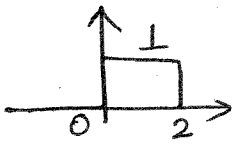
5). Amplitude-Shifting $\begin{cases} \rightarrow \text{upward} \\ \rightarrow \text{downward} \end{cases}$

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



Case (i) : when \$k > 0\$: upward shifting
 Ex: \$k = 1\$

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



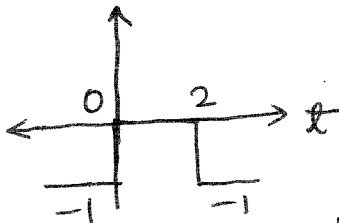
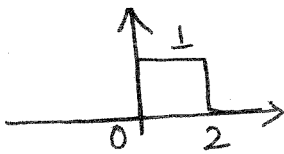
$$x(t) = \begin{cases} 0, & t < 0 \\ 1, & 0 < t < 2 \\ 0, & t > 2 \end{cases}$$

$$y(t) = \begin{cases} 1+0, & t < 0 \\ 1+1, & 0 < t < 2 \\ 1+0, & t > 2 \end{cases} = \begin{cases} 1, & t < 0 \\ 2, & 0 < t < 2 \\ 1, & t > 2 \end{cases}$$

Case (ii) : when \$k < 0\$: downward shifting

Ex: \$k = -1\$

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

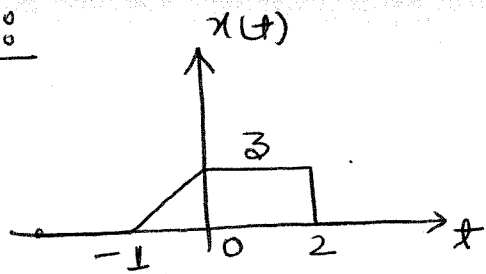


$$x(t) = \begin{cases} 0, & t < 0 \\ 1, & 0 < t < 2 \\ 0, & t > 2 \end{cases}$$

$$y(t) = \begin{cases} -1+0, & t < 0 \\ -1+1, & 0 < t < 2 \\ -1+0, & t > 2 \end{cases}$$

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

Q.N-0

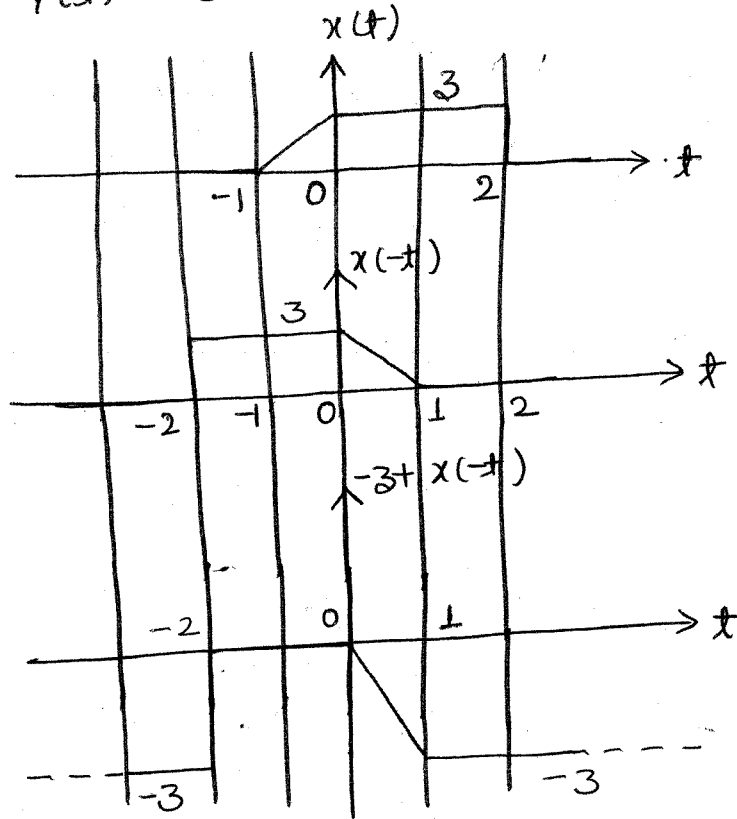


draw $y(t)$ where

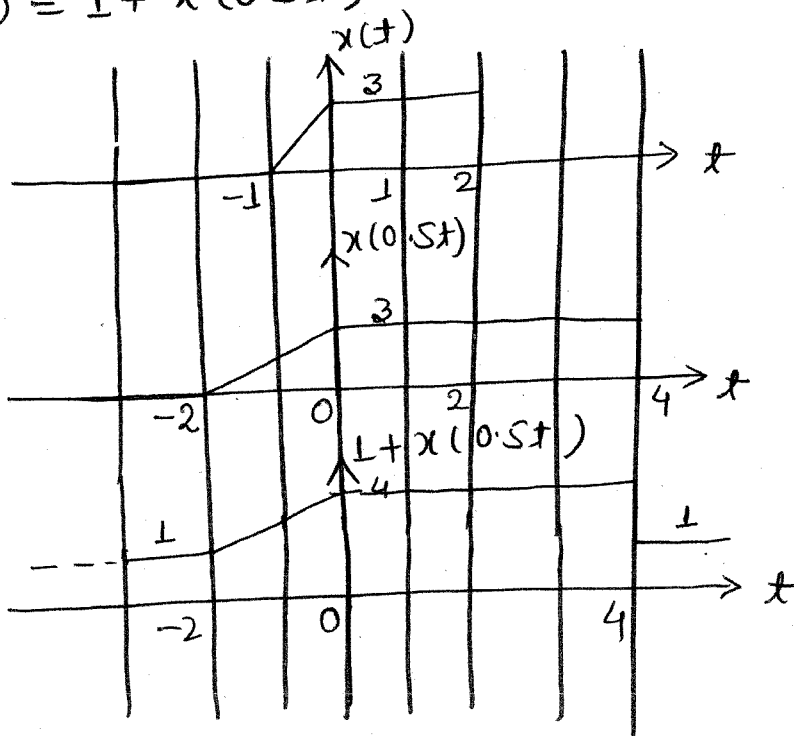
(i) $y(t) = -3 + x(-t)$

(ii) $y(t) = 1 + x(0.5t)$

Solution: (i) $y(t) = -3 + x(-t)$



(ii) $y(t) = 1 + x(0.5t)$

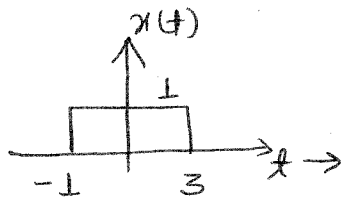


$$\frac{20}{0.5} = 4 \quad \frac{10}{0.5} = 2$$

$$\frac{-10}{0.5} = -2$$

$$\frac{0}{0.5} = 0$$

Q.N :-



Draw signal $y(t)$ if

$$y(t) = x(2t+3)$$

NOTE :-

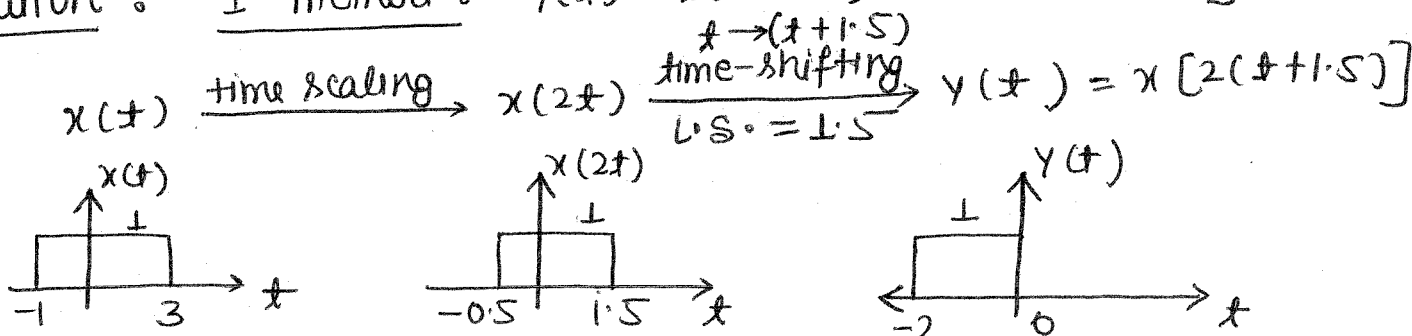
1. $x(2t) \xrightarrow{\text{left shift} = 1} x[2(t+1)]$
 $t \rightarrow (t+1)$

2. $x(-3t) \xrightarrow[\text{Right-shift} = 2]{t \rightarrow (t-2)} x[-3(t-2)] = x[-3t+6]$

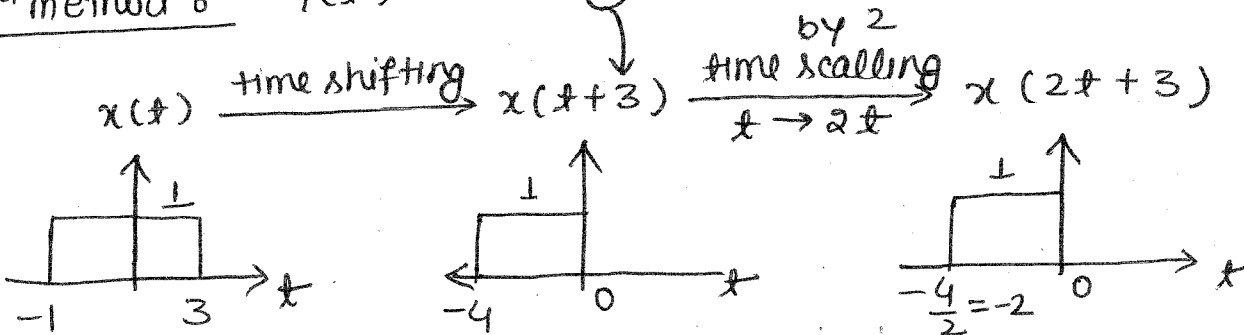
3. $x(t+1) \xrightarrow[\text{perform time scaling by 2}]{t \rightarrow 2t} x(2t+1)$

Ex :- $x(t-4) \xrightarrow[\text{perform time scaling by } (-0.5)]{t \rightarrow -0.5t} x(-0.5t-4)$

Solution :- 1st method :- $y(t) = x(2t+3) = x[2(t+1.5)]$



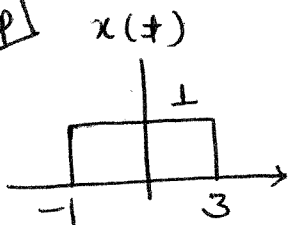
2nd method :- $y(t) = x(2t + \frac{3}{2})$



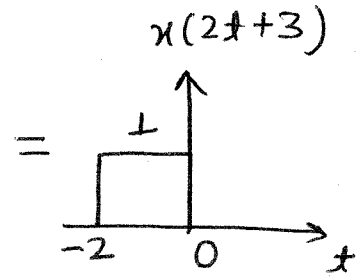
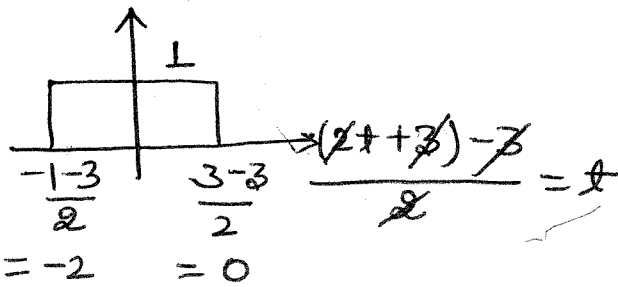
$$x(t) \longrightarrow x(t+1.5) \longrightarrow x(2t+1.5) \neq y(t)$$

3rd method (Trick) :

Imp

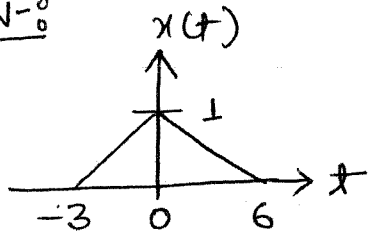


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NOTE :- when in any question is given that relate to fourier transform & laplace transform then this trick is not applicable. so for this 1st & 2nd method is applicable only.

Q.N :-



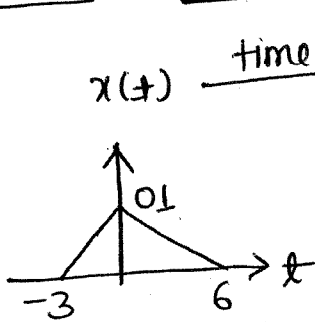
draw signal y(t) if

$$y(t) = x(-2t+1)$$

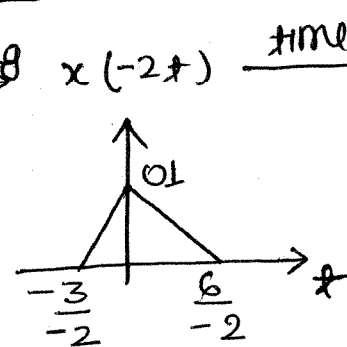
Solⁿ :-

1st method :

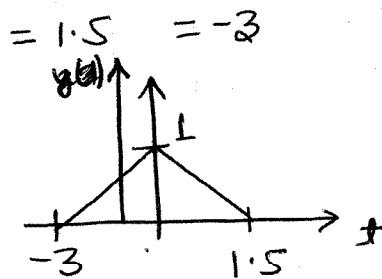
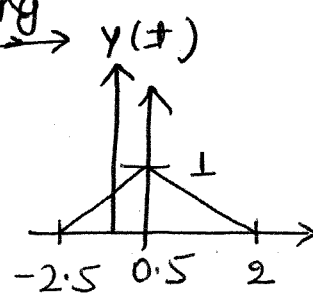
$$y(t) = x(-2t+1) = x[-2(t-0.5)] \xrightarrow{\text{Right shifting}} = 0.5$$



time scaling

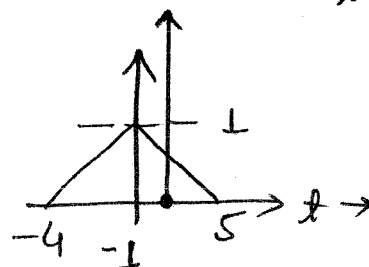
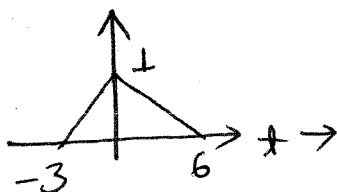


time shifting

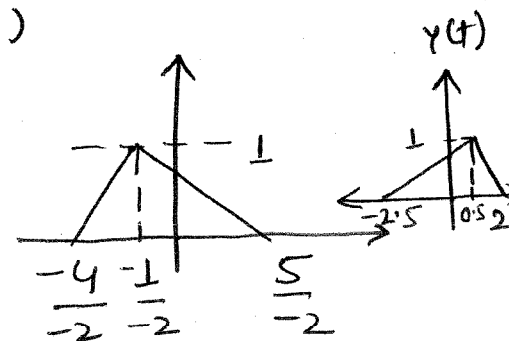


2nd method : $y(t) = x(-2t+1)$

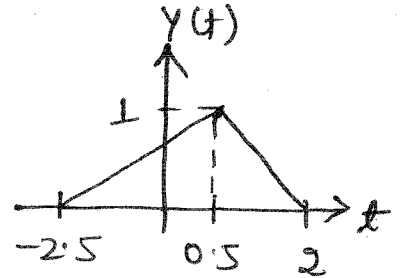
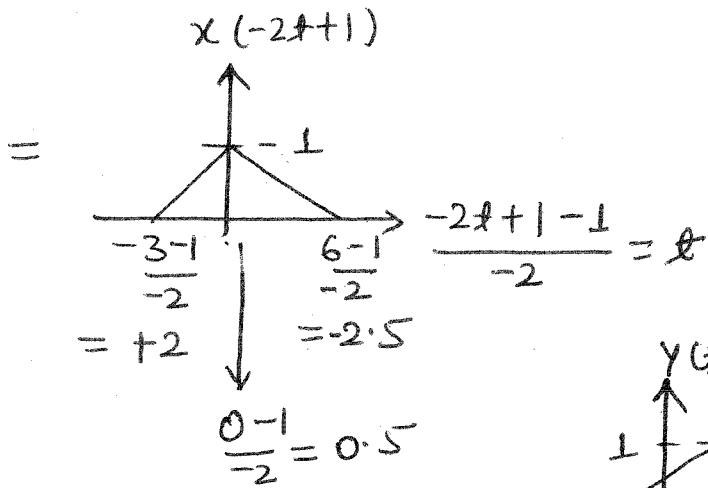
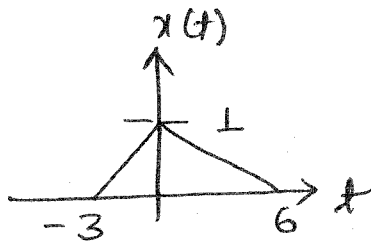
time shifting
 $t \rightarrow (t+1)$



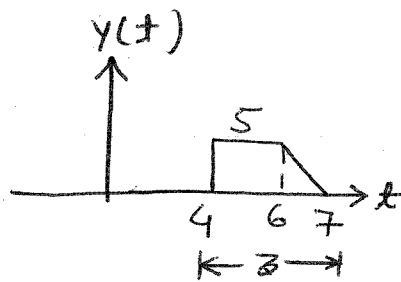
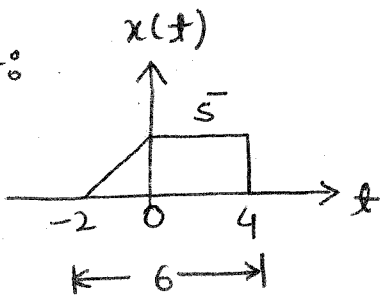
time scaling
 $x(-2t+1) = y(t)$



3rd method (Truck) :

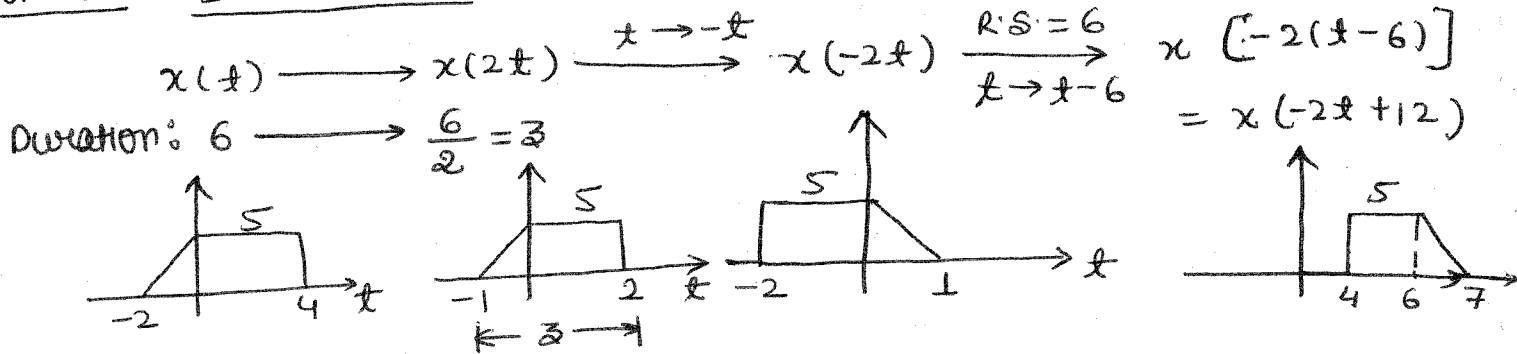


Q.N :-



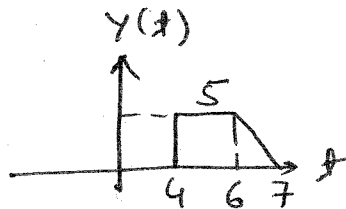
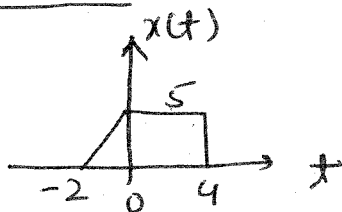
Find $y(t)$ in term of $x(t)$.

Solⁿ :- 1st method :



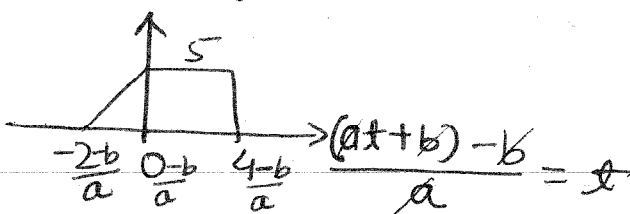
2nd method :

Imp



$y(t) = x(at+b), a=?, b=?$

$x(at+b) \xrightarrow{t}$



$\frac{-2-b}{a} = 7 \quad \& \quad \frac{4-b}{a} = 4$
 $-2-b = 7a \quad \& \quad 4-b = 4a$
 $-2 = 7a+b \quad \& \quad 4 = 4a+b$

$-6 = 3a$

$b = +12$

$a = -2$

$y(t) = x(-2t+12)$