Operations performed on the Independent Variable

(i) Time Scaling
(ii) Time Reversal (Reflection)
(iii) Time shifting

(i)Time Scaling:

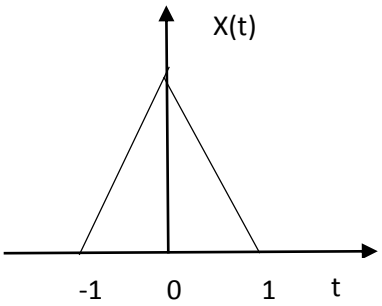
Let $x(t)$ be a continuous Time signal, then

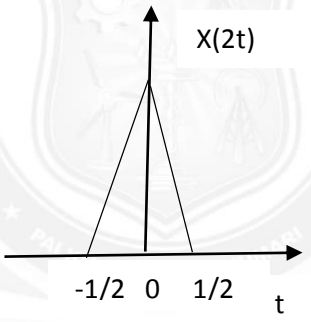
$$y(t) = x(at)$$

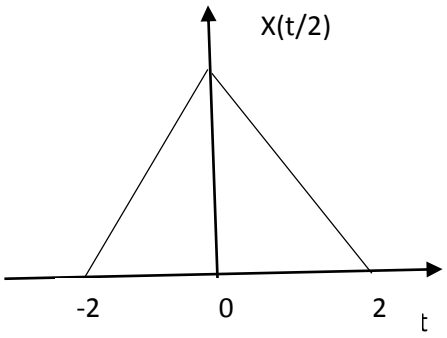
Case (i) : If $a > 1$, the signal $y(t)$ is a compressed version of $x(t)$.

Case(ii) : If $0 < a < 1$, the signal $y(t)$ is an expanded version of $x(t)$.

Example:







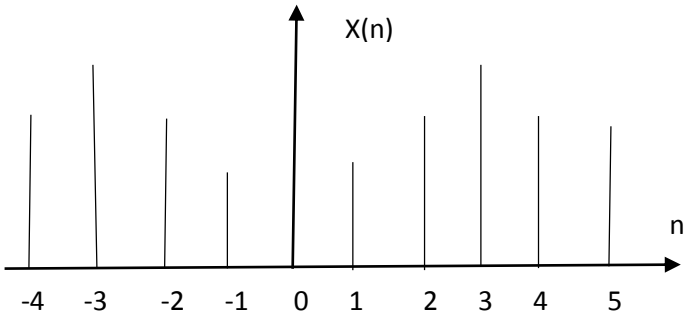
Let $x(n)$ be a Discrete Time signal, then

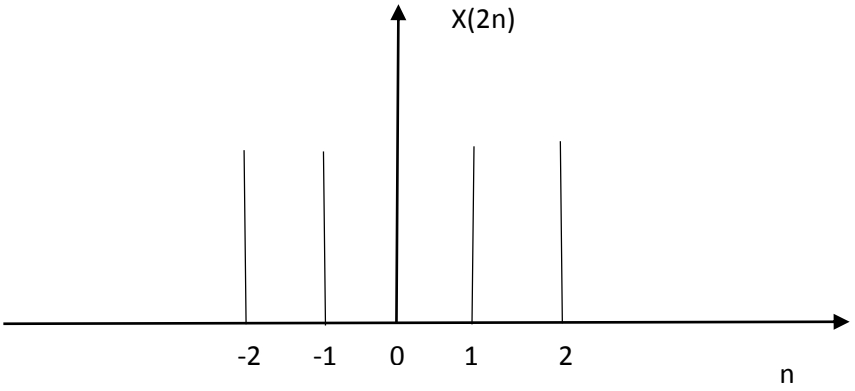
$$y(n) = x(kn)$$

Case (i): If $K > 1$, some values of the Discrete time signal are lost.

*Case (ii):*If $0 < k < 1$, the signal $y(n)$ is an expanded version of $x(n)$.

Example:





(ii)Time Reversal:

Let $x(t)$ denote a continuous time signal ,then $y(t) = x(-t)$. $y(t)$ is the reflected version of $x(t)$ about $t = 0$.

Example:

(iii)Time shifting:

Let $x(t)$ denote a continuous time signal. Then

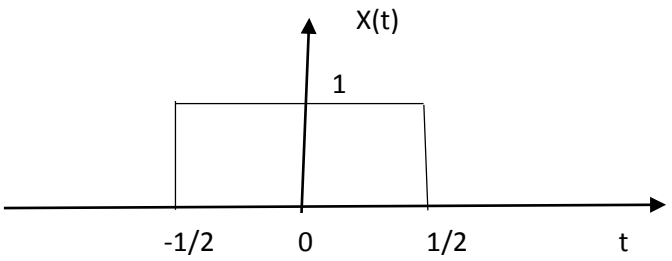
$$y(t) = x(t - t_0).$$

Where, $t_0 \rightarrow Amount\ of\ time\ shift.$

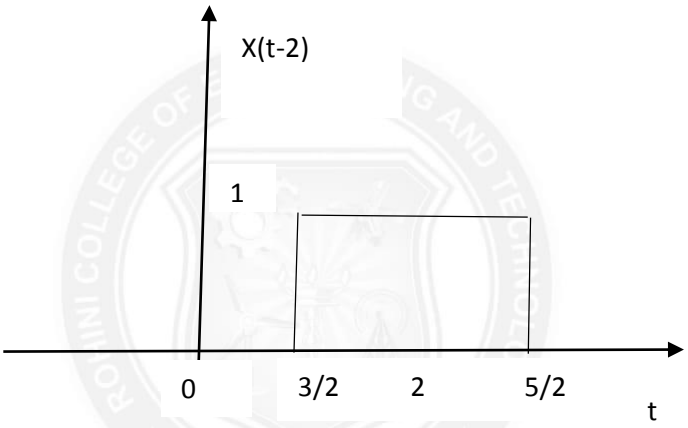
*Case (i):*If $t_0 > 0$, then $x(t)$ is shifted to right (delay).

*Case (ii):*If $t_0 < 0$, then $x(t)$ is shifted to left (advance).

Example: 1 Fig below shows a rectangular pulse $x(t)$ is unit amplitude and unit duration. Find $y(t) = x(t-2)$.



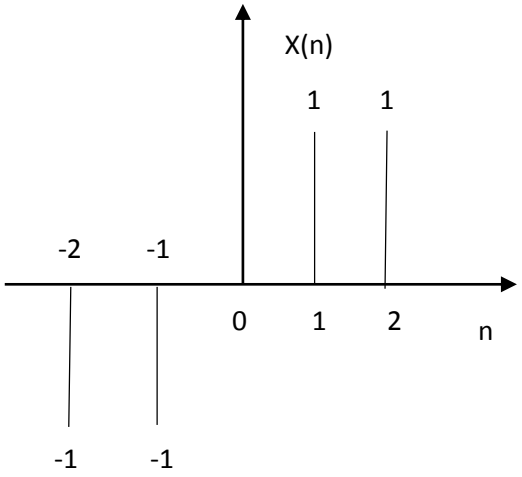
Soln:

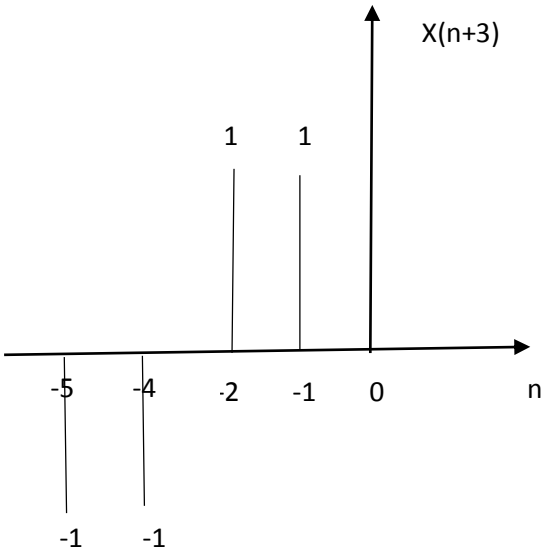


2. The Discrete signal $x(n) = \begin{cases} 1\ ,\ n = 1,2 \\ -1\ ,\ n = -1,-2 \\ 0\ ,n = 0\ \ and\ |n| > 2 \end{cases}$.

Find $y(n) = x(n+3)$.

Soln:



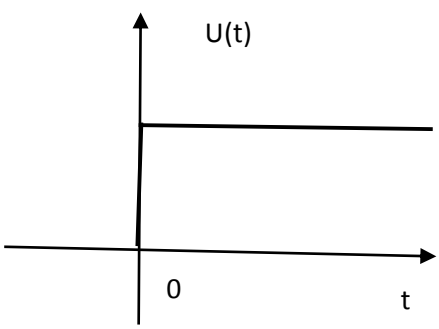


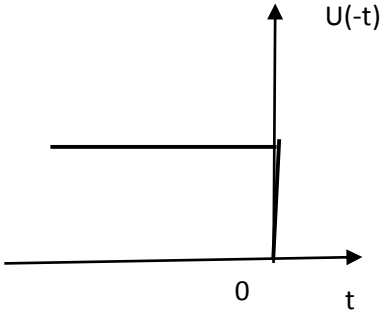
3. Sketch the following signals.

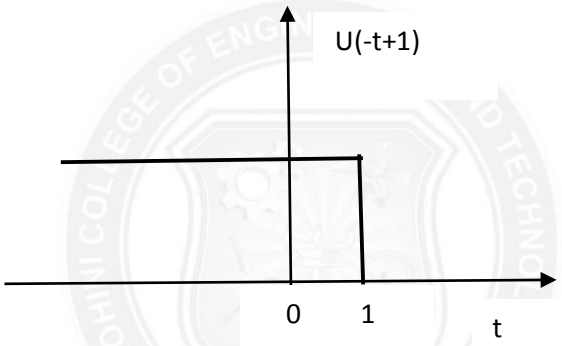
(i) $u(-t+1)$ (ii) $-2u(t-1)$ (iii) $r(-t+2)$ (iv) $\pi(t+3)$

Soln:

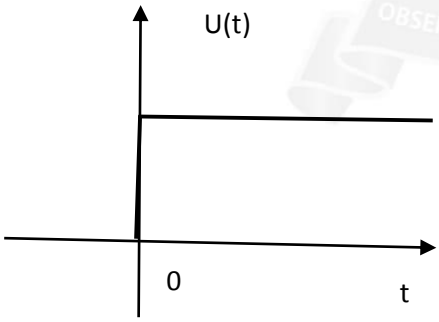
(i) $u(-t+1)$

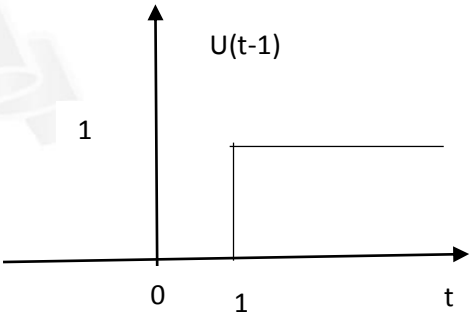


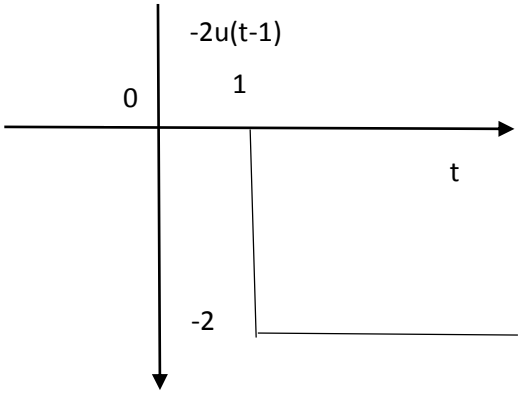




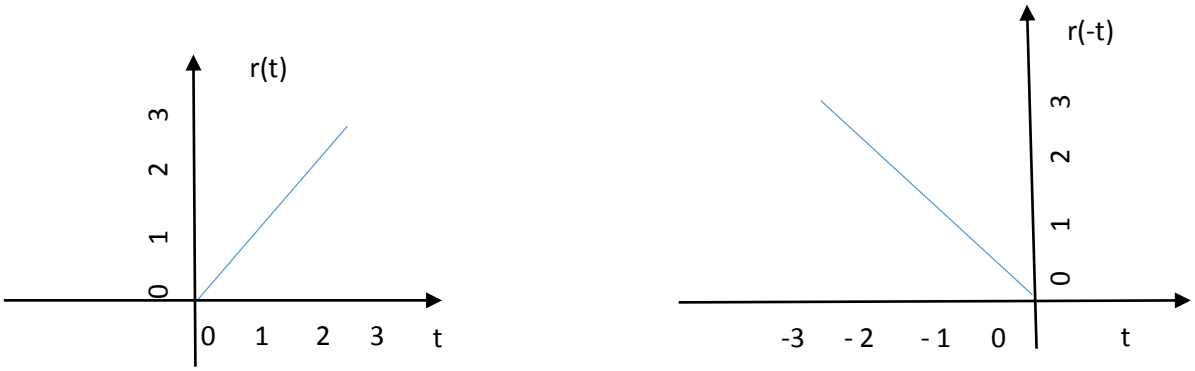
(ii) $-2u(t-1)$

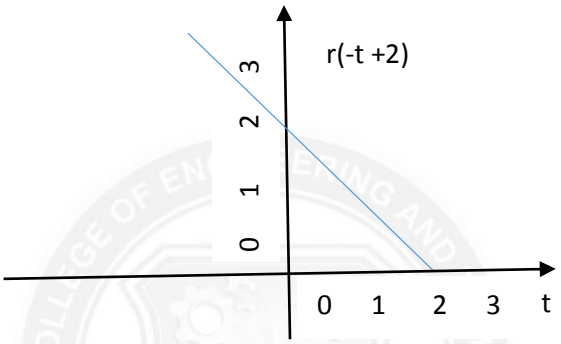




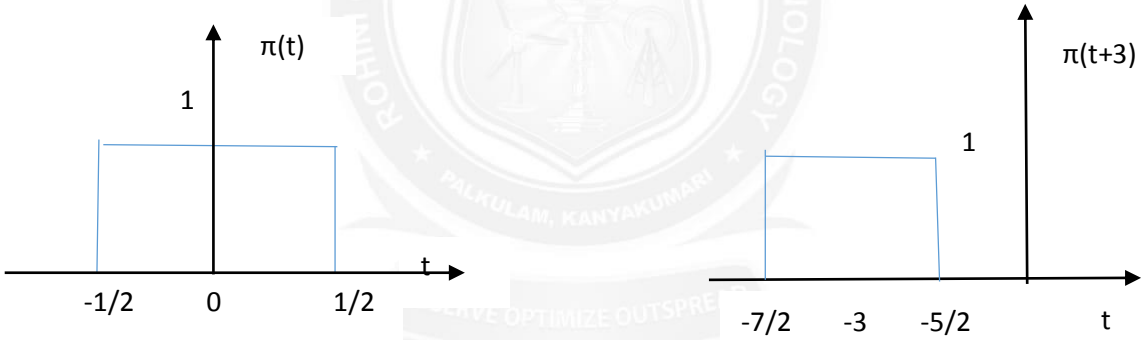


(iii) $r(-t+2)$





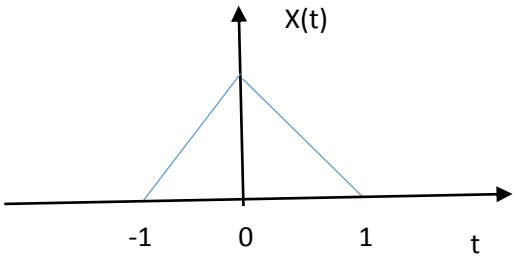
(iv) $\pi(t+3)$



4. A triangular pulse signal $x(t)$ is shown below. Sketch the following signals

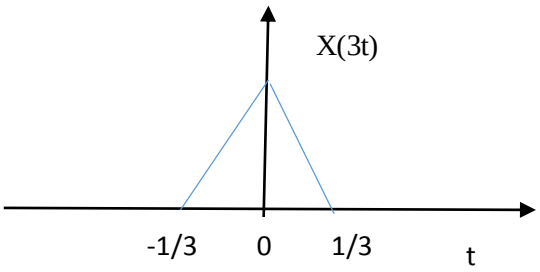
a) $x(3t)$ b) $x(3t+2)$ c) $x(-2t+1)$ d)$x(2(t+2))$ e) $x(2(t-2))$

f)) $x(3t)+x(3t+2)$

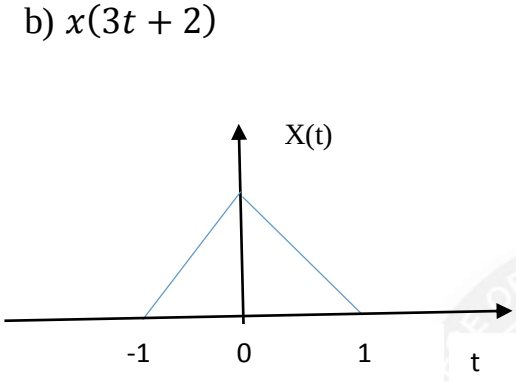


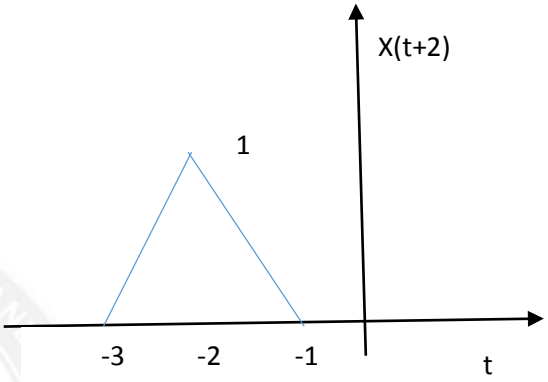
Soln:

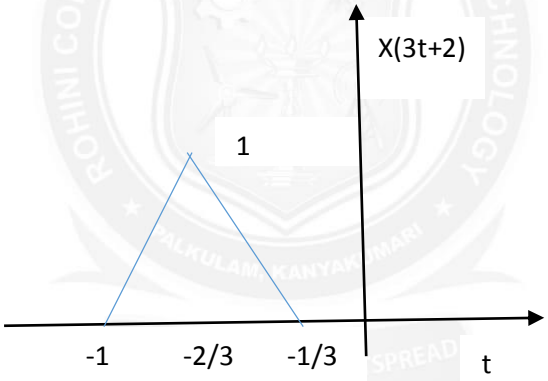
a) $x(3t)$



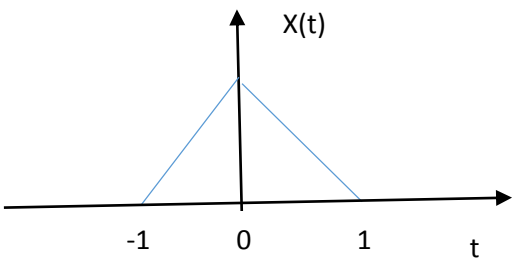
b) $x(3t+2)$

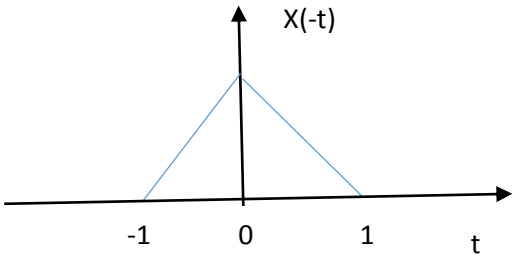


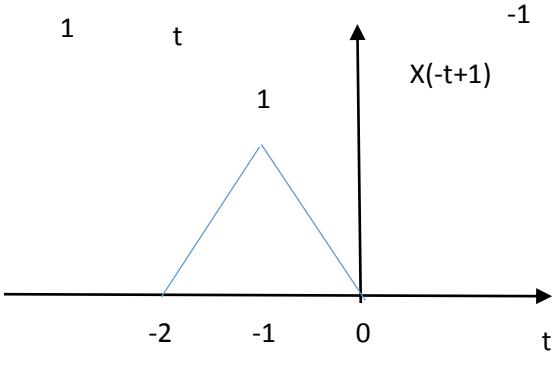


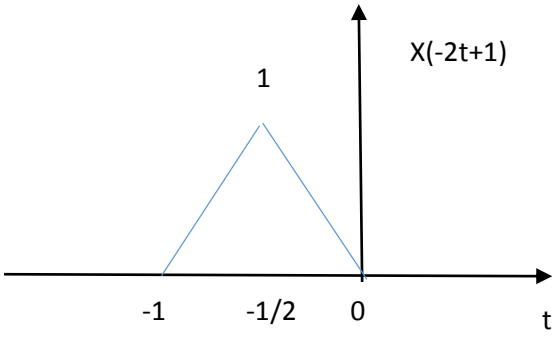


c) $x(-2t+1)$

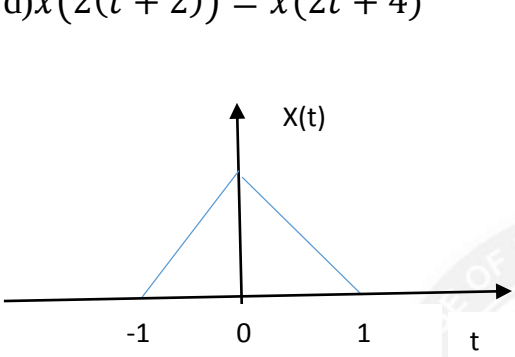


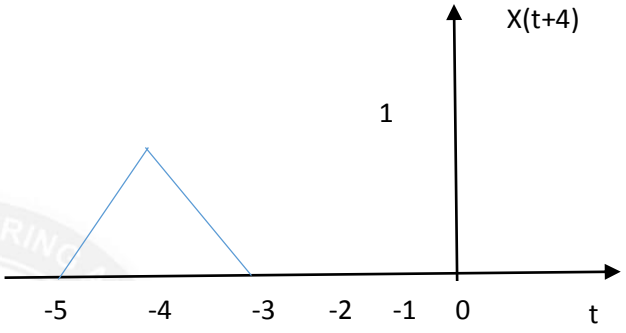


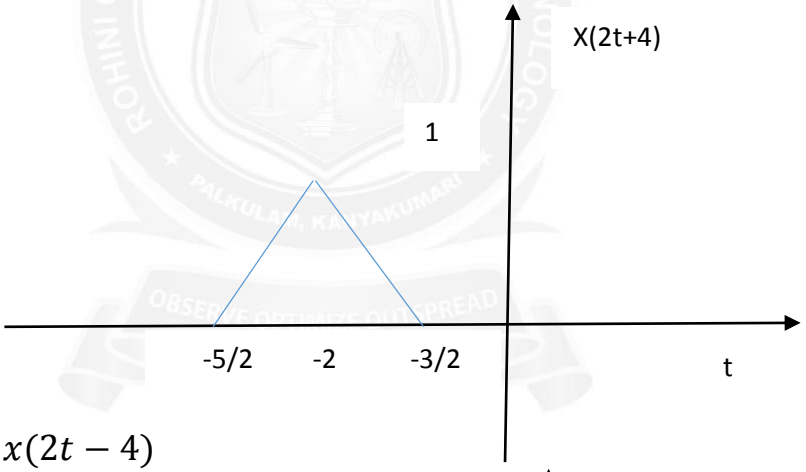




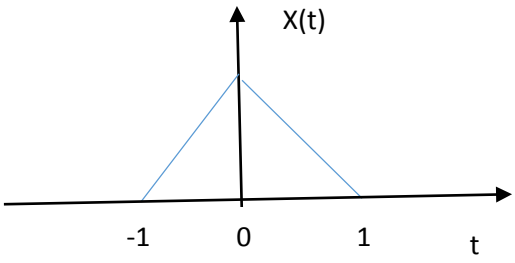
d)$x\big(2(t+2)\big) = x(2t+4)$

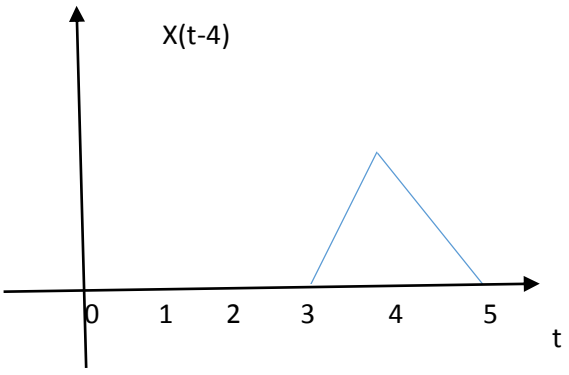


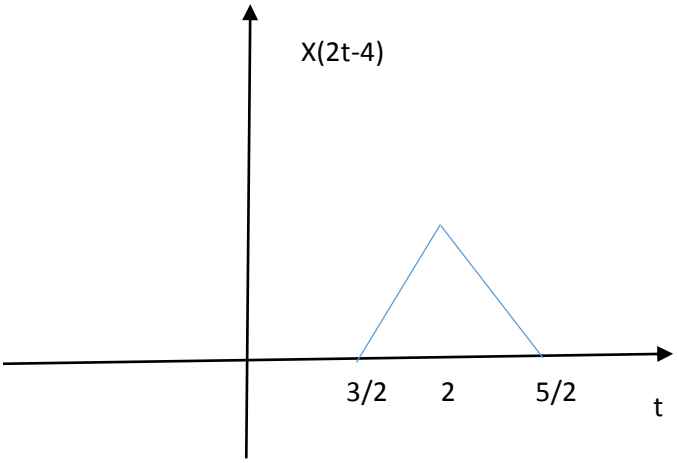




e) $x\big(2(t-2)\big) = x(2t-4)$







f)) $x(3t) + x(3t + 2)$