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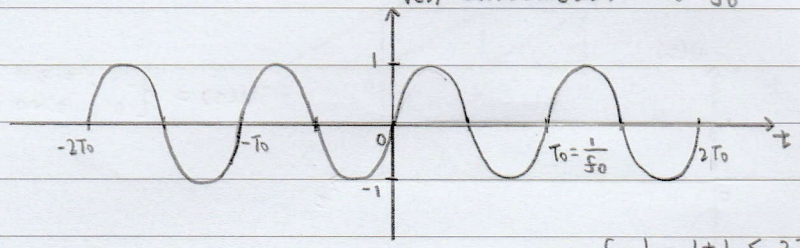
Esmund Lim — signal Tutorial 2

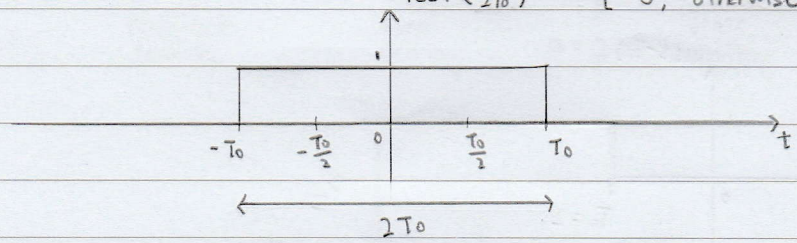
1) $V(t) = \sin(2\pi f_0 t)$ Evaluate $\int_{-\infty}^{\infty} y(t)\,dt$

a)

$V(t) = \sin(2\pi f_0 t)$ $T_0 = \frac{1}{f_0}$

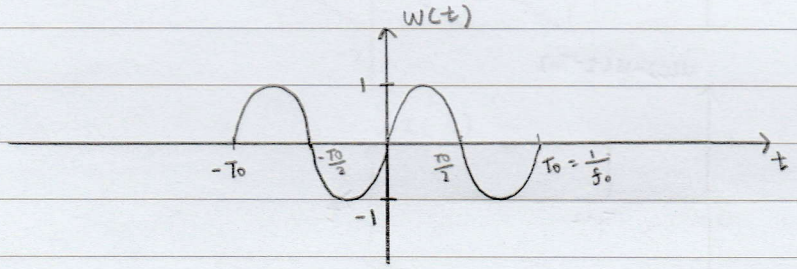



$\text{rect}\left(\frac{t}{2T_0}\right) = \begin{cases} 1, & |t| \le 2T_0/2 \\ 0, & \text{otherwise} \end{cases}$ $\quad -2T_0/2 \le t \le 2T_0/2$



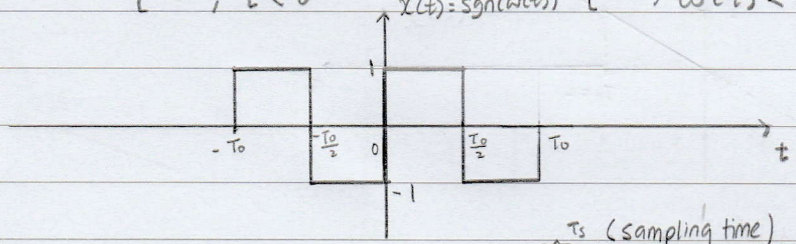

$\text{rect}\left(\frac{t}{T}\right) = \begin{cases} 1, & |t| \le T/2 \\ 0, & \text{otherwise} \end{cases}$

↳ constant
Duration of rect pulse



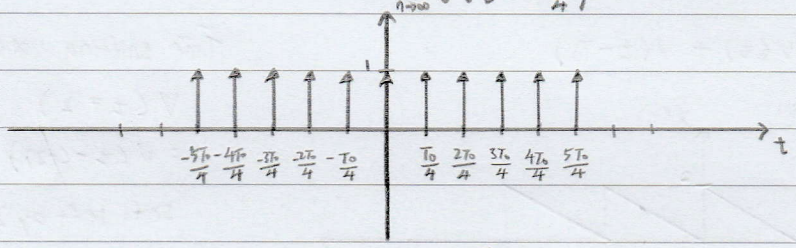

b) $\text{Sgn}(t) = \begin{cases} 1, & t > 0 \\ 0, & t = 0 \\ -1, & t < 0 \end{cases}$ $\quad \text{sgn}(w(t)) = \begin{cases} 1, & w(t) > 0 \\ 0, & w(t) = 0 \\ -1, & w(t) < 0 \end{cases}$

$x(t) = \text{sgn}(w(t))$

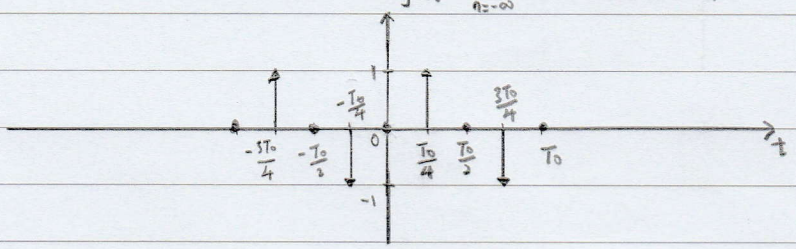



$T_s$ (sampling time)

c) $\sum_{n=-\infty}^{\infty} \delta\left(t - n\frac{T_0}{4}\right)$ Sampling process




$y(t) = \sum_{n=-\infty}^{\infty} x(t) \times \delta\left(t - n\frac{T_0}{4}\right)$




$\int_{-\infty}^{\infty} y(t)\,dt$

$= \int \delta(t - \frac{T_0}{4}) - \delta(t - \frac{3T_0}{4}) - \delta(t + \frac{T_0}{4}) + \delta(t + \frac{3T_0}{4})\,dt$

$= 1 - 1 - 1 + 1$

$= 0$

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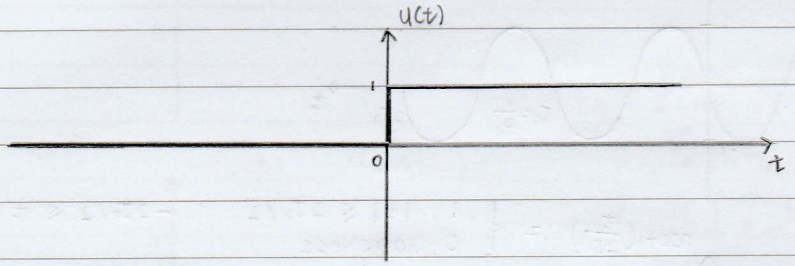
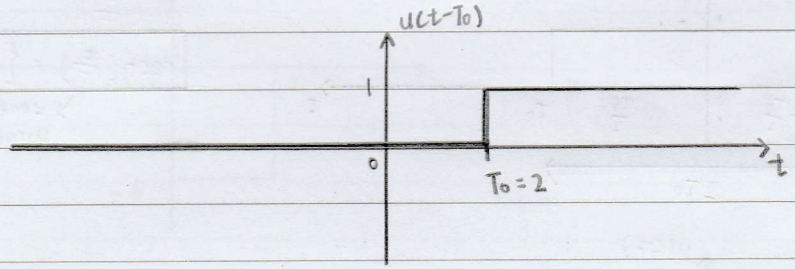
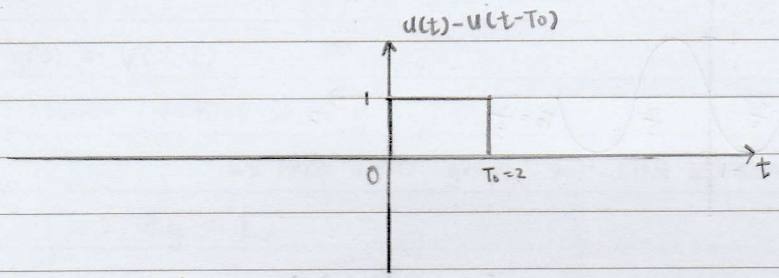
2) $x(t) = \sum_{n=-1}^{1} v(t - nT_0)$ and $y(t) = -x\left(\frac{t+4}{2}\right)$

Where $v(t) = t\,[u(t) - u(t-T_0)]$, and $T_0 = 2$

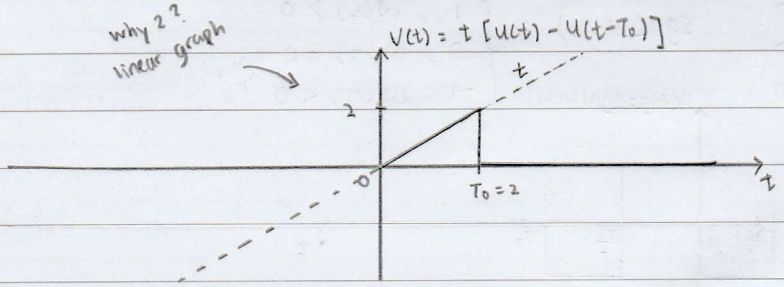



$$u(t) = \begin{cases} 1, & t \geq 0 \\ 0, & t < 0 \end{cases}$$



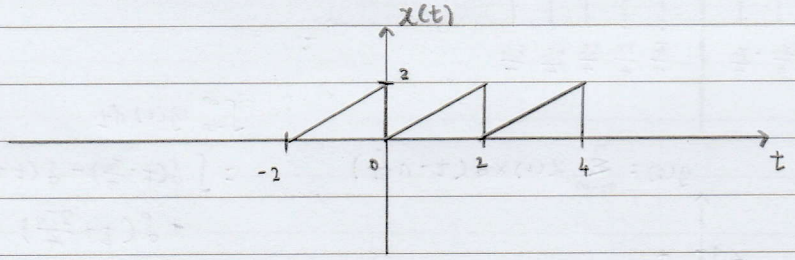




why 2 ?
linear graph




$$x(t) = \sum_{n=-1}^{1} v(t - nT_0)$$

$$= v(t + T_0) + v(t) + v(t - T_0)$$




Time shifting $x(t-T)$ or $x[n-k]$

$v(t+2)$ $v(t-2)$

$= v(t-(-2))$ shift right by 2

shift left by 2

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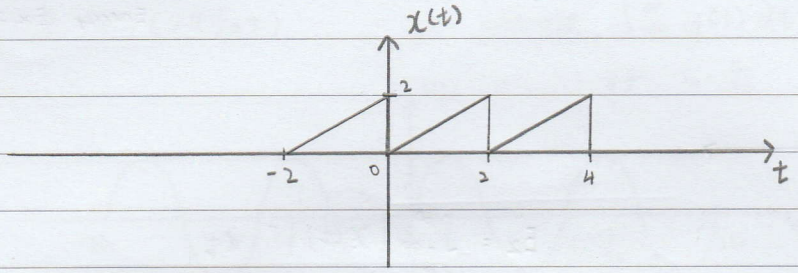
continue (2)




Time shifting $x(t-T)$

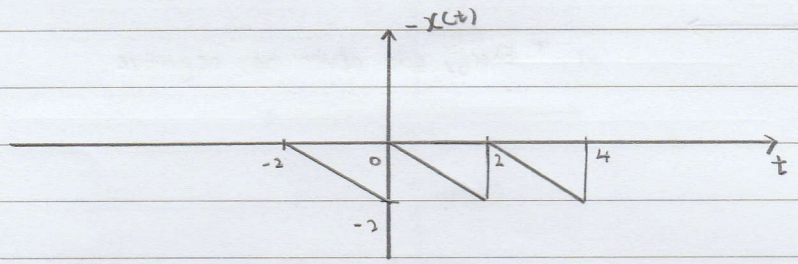
Time scaling $x\left(\frac{t}{a}\right)$ $a<0$ (inverted)

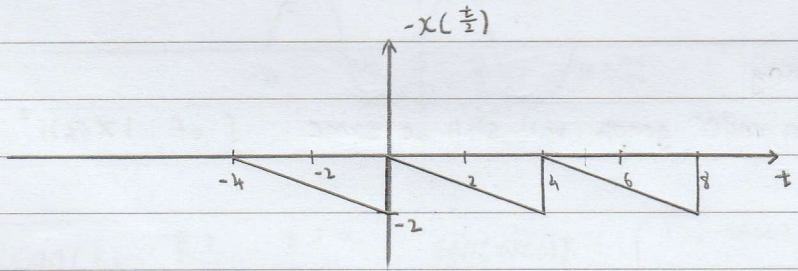
↳ $|a|>1$ expand duration

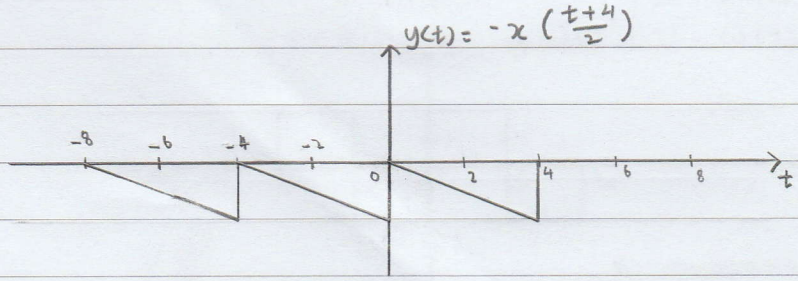
↳ $|a|<1$ compress duration

$x(t) \longrightarrow -x(t) \longrightarrow -x\left(\frac{t}{2}\right) \longrightarrow -x\left(\frac{t+4}{2}\right)$

Amplitude scaling — time scaling $a=2$ — time shifting $T=-4$



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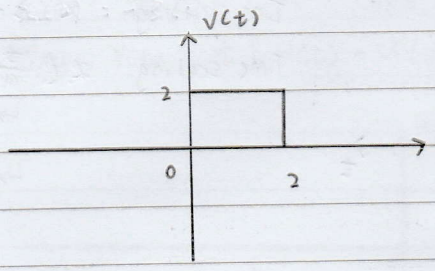
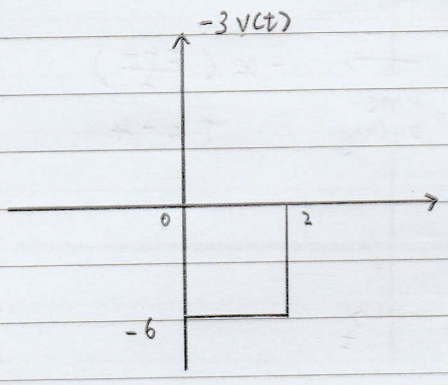
3) Energy $E_x = \int_{-\infty}^{\infty} |x(t)|^2 dt$




$E_x = \int_{-\infty}^{\infty} |x(t)|^2 dt$

$= \int_{-\infty}^{\infty} (-3\,v(t))^2 dt$

$= 9 \int_{-\infty}^{\infty} |v(t)|^2 dt$ $E_v$ (Energy of v)

$= 9E_v$

* Energy can never be negative

b) $y(t) = v(t-3)$

↳ time shifting

↳ Area under graph will still be same ∫ of $|x(t)|^2$

$\therefore E_y = E_v$