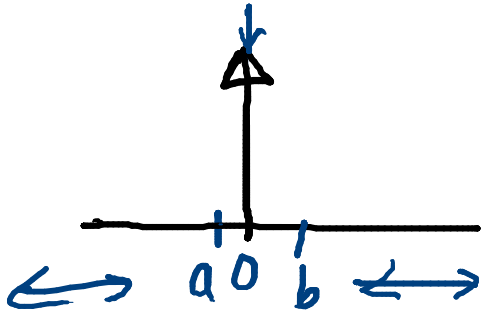
31/7/2017



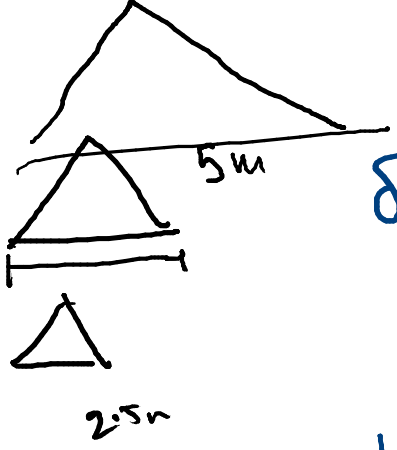
$$\int_{-\infty}^{\infty} \delta(t)\,\phi(t)\,dt$$

$$= \begin{cases} \phi(0) & ; \quad a > 0 > a \\ 0 & ; \quad b > a > 0 \text{ or } -ve \\ & \quad \text{+ve side} \\ \text{un} & \end{cases}$$

$$\delta(t)\,\phi(t) = \phi(0)\,\delta(t)$$

$$\delta(t - t_0)\,\phi(t) = \phi(t_0)\,\delta(t - t_0)$$

$$\int_a^b \delta(t) = 1$$



$$\delta[n] = 1 \quad ; \quad n = 0$$
$$= 0 \quad ; \quad n \neq 0$$

$$u[n] = 1 \quad ; \quad n \geq 0$$
$$= 0 \quad ; \quad n < 0$$

32 kbps
320 kbps

mp3 → 64 kbps
128 k
320 kbps

$x[0.5n]$

$x[2n]$

① Time shift

② Scaling

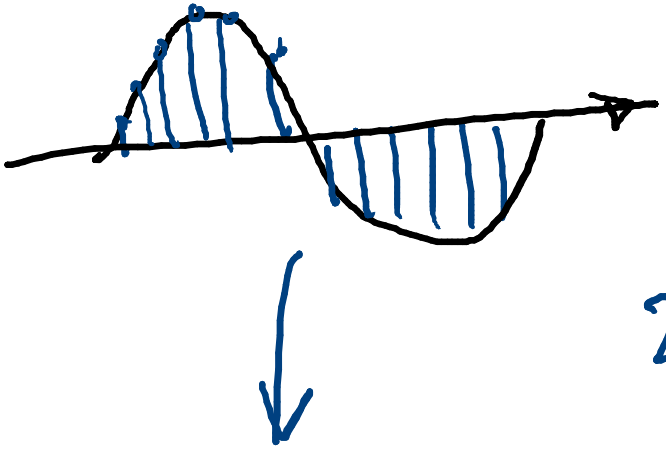
$x(t) \rightarrow x(at)$

$x(t) \rightarrow x(t-3)$

$x(t+3)$

audioread

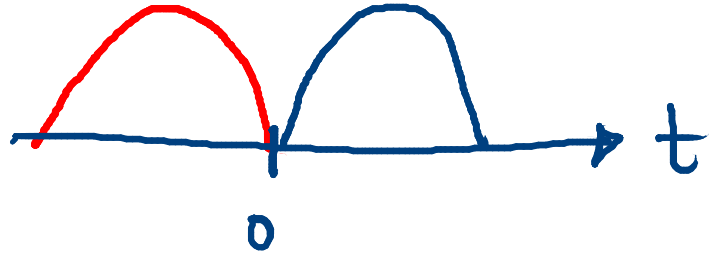
$x(2t)$ $x[2n]$



Nyquist

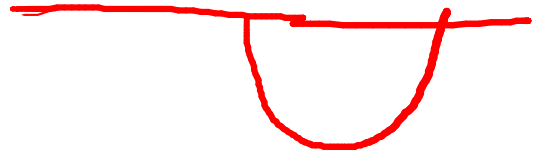
$-x(-t)$

$2x(2t)$



2 Hz

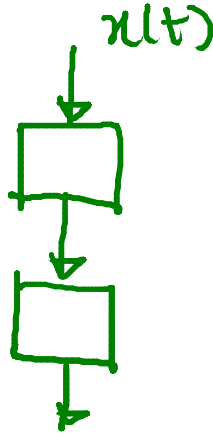
4 samples



(3) Reflection (time-reversal):

$x(t) \rightarrow x(-t)$ ✓

$x(t) \longrightarrow x(at+b)$ $\quad x(t) \longrightarrow x(-t+1)$



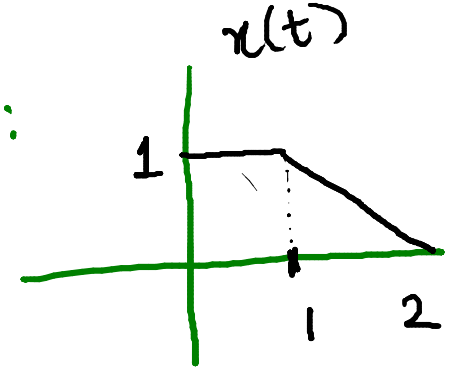
b : shift

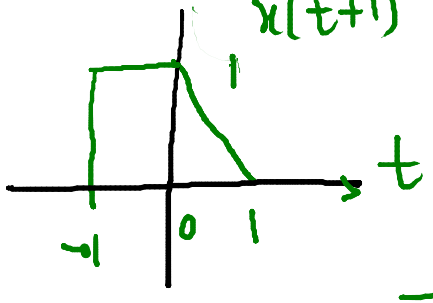
a : scaling or reversal operation.

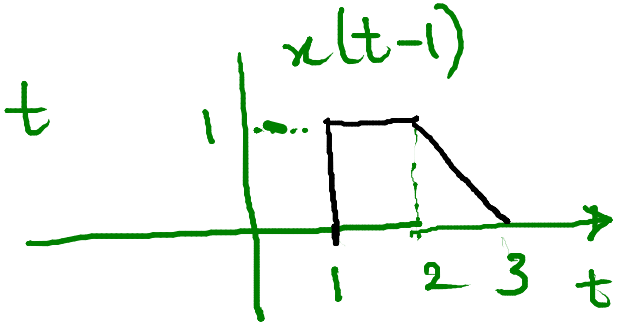
$x(t) \longrightarrow x(2t+3)$

$x(t) \longrightarrow x(-t+2)$

e.g.:







① $x(t+1)$

② $x(t-1)$

③ $x(-t+1)$

④ $x(2t+1)$

Flipping

Shifting

$x(t) \rightarrow x(-t) \rightarrow x(-(t-t_0))$

$x(t) \rightarrow x(t-t_0) \rightarrow x(-t-t_0)$

shift

Flip

$x(t) \rightarrow x(at) \rightarrow x(a(t-b))$

$x(t) \rightarrow x(t-b) \rightarrow x(at-b)$

?

$x(-(t-1))$

$$x(t) \rightarrow x(-t) \rightarrow x(-(t-1))$$

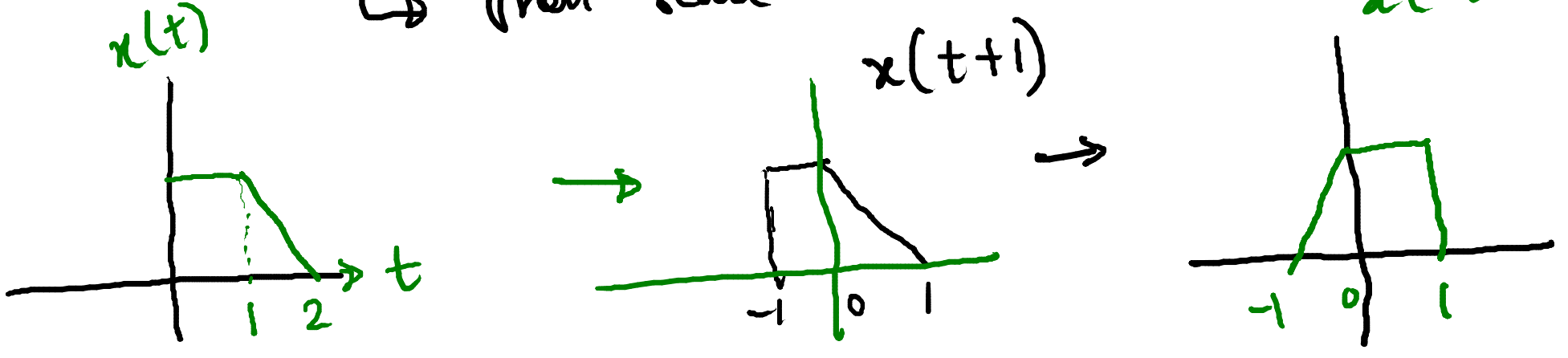
$x(-$

$x(at+b)$

$x(-t+1)$

↳ First shift by b

↳ Then scale.



$x(t) \rightarrow x(at) \rightarrow x(a(t-b))$

$x(t) \rightarrow x(t-b) \rightarrow x(at-b)$

Point to be noted:

$x(at+b)$

- First Shift
- Then Scale / reverse.

$a = -1 \quad b = -1$

$x\left(\frac{3}{2}t + 1\right)$

$\frac{3}{2}(t)$

$\frac{3}{2}(t-b)$

$x(t) \rightarrow x\left(\frac{3}{2}t\right) \rightarrow x\left(\frac{3}{2}(t-t_0)\right)$

$x(t) \rightarrow x(t-t_0) \rightarrow x(at-t_0)$

$x(t)$

$\frac{3}{2}t+1$

$x\left[\frac{3}{2}\left(t+\frac{2}{3}\right)\right]$

$$x\left(\frac{3}{2}t+1\right) = x\left(\frac{3}{2}\left(t+\frac{2}{3}\right)\right)$$

✓

1. Shift left by 1 unit
2. Scale by factor $\frac{3}{2}$

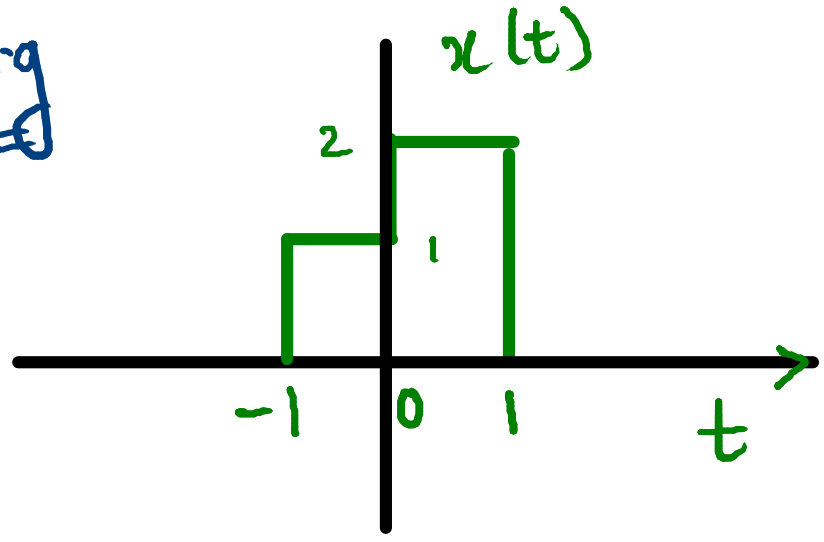
1. Scale by factor of $\frac{3}{2}$
2. Then shift by $\frac{2}{3}$

$x(at+b)$

1. Shift by b
2. Scale/flip a

divide x-axis by a

e.g



① $x(t-1)$

② $x(2-t)$

③ $x(t+4)$

④ $x(t/2+4)$