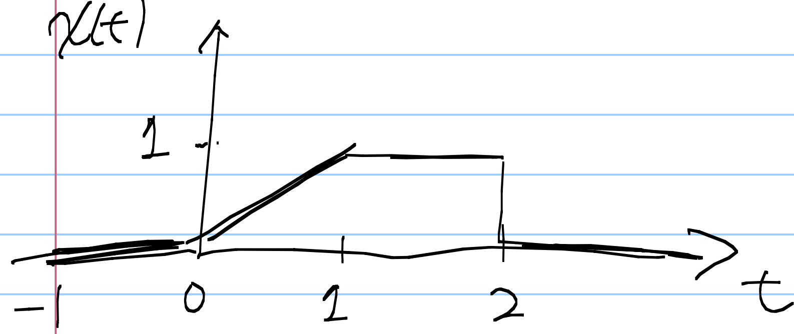
* Transformations of the time index

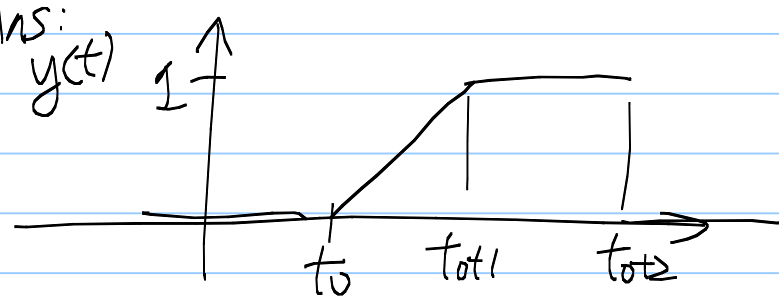
① Time-shift (DVR)

Q: For an $x(t)$ described by the following figure



let $y(t) = x(t - t_0)$. Plot $y(t)$ vs. t.

Ans:



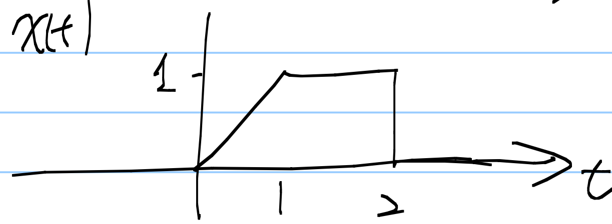
when $t_0 > 0$, we say "shifted to the right." "delay t_0 seconds"

when $t_0 < 0$, we say "shifted to the left." "advance t_0 second

[Also see Prof. Balakrishnan's handout.]

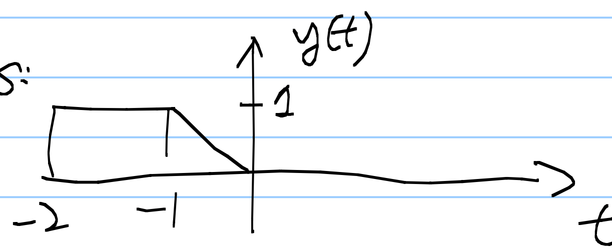
② Time-reversal (play backward)

Q: Given the same $x(t)$



let $y(t) = x(-t)$ plot $y(t)$ vs. t.

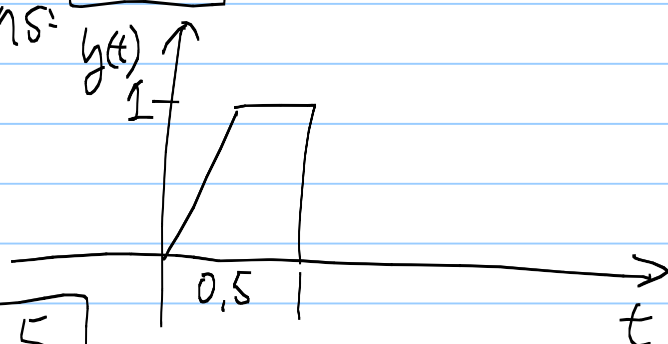
Ans:



③ Time-scaling

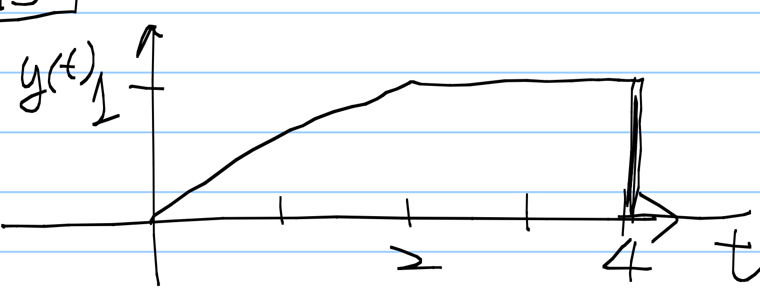
Q: Given the same $x(t)$, let $y(t) = x(\alpha t)$ where $\alpha > 0$. Plot $y(t)$ vs. t for $\alpha = 2$ and $\alpha = 0.5$ respectively.

Ans: $\boxed{\alpha = 2}$



fast forward

$\boxed{\alpha = 0.5}$



slow motion

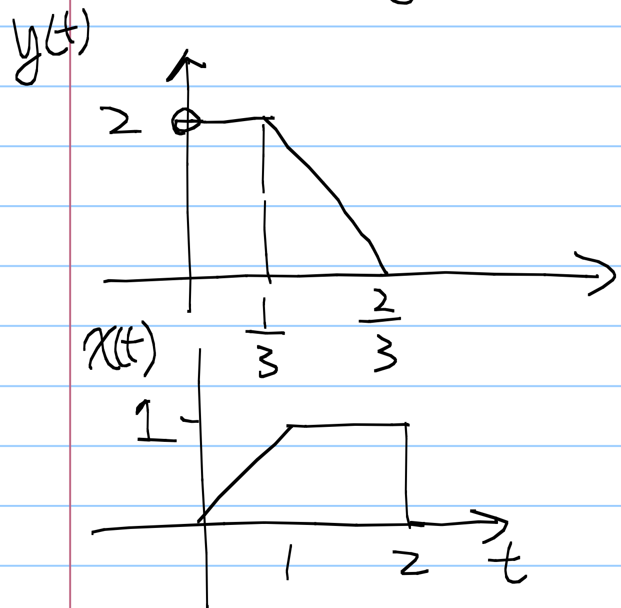
Note Title 1/13/2010

* Composite Transformation

Q: Given the same $x(t)$, let

$y(t) = 2 \cdot x(2-3t)$.

Plot $y(t)$ vs. t.



Tip: Plug-in several values of t that will help you decide the shape of the final signal.

ex: $t=0$ gives $2-3t=2$, is a good choice $\quad x(2-3t)=x(2)$, $y(0)=2x(2)$

$t=\frac{1}{3}$ $\quad 2-3t=1$ $\quad x(2-3t)=x(1)$, $y(\frac{1}{3})=2x(1)$

$t=\frac{2}{3}$ $\quad 2-3t=0$ $\quad x(2-3t)=x(0)$, $y(\frac{2}{3})=2x(0)$

Exercise: Given $x(t)$ being

Plot $y(t) = \frac{1}{3} x(4 - 0.5t)$.

Ans: Good pts:

$t = 10$ $\quad 4 - 0.5t = -1$

$t = 4$ $\quad 2$

$t = 2$ $\quad 3$

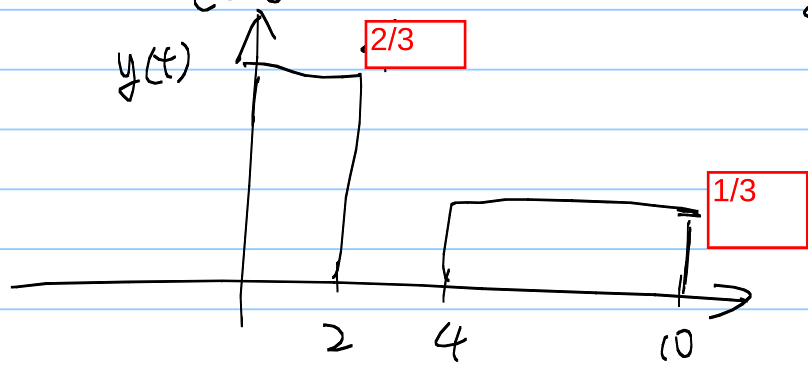
$t = 0$ $\quad 4$

$y(10) = \frac{1}{3} x(-1)$

$y(4) = \frac{1}{3} x(2)$

$y(2) = \frac{1}{3} x(3)$

$y(0) = \frac{1}{3} x(0)$



Prof. Balakrishnan's handout.

* Classification #3: By the period.

* We say $x(t)$ is a periodic signal with $\boxed{\text{period } T}$ if we let $y(t) = x(t-T)$ be the shifted version of $x(t)$, then the new signal "looks" exactly like the old signal: sometimes we just write

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

For DT: if $x[n] = x[n-N]$, then $x[n]$ is periodic with period N