Mathematical Representation of Signal Waveform

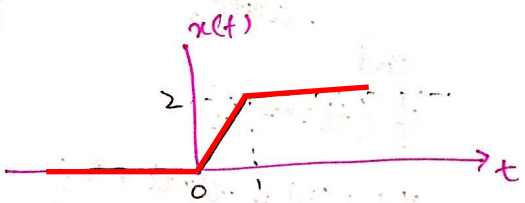
⇒ The mathematical representation is often a combination of RAMP & STEP signals.

→ Waveform with no discontinuities can be represented only as ramp signals.

→ Waveforms having discontinuities + some ctt values can be represented only with step signals.

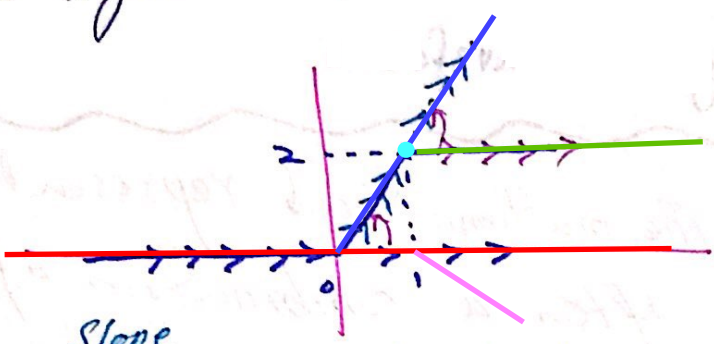
# of step signals = # of discontinuities in the signal.

Example 1



Solution :- No discontinuities. So it can be represented using RAMP signals only.

→ Start from the left and follow the signal.



$x(t) =$ 0 + $\frac{2}{1}\gamma(t-0)$ − $\frac{2}{1}\gamma(t-1)$

Slope

passing through origin

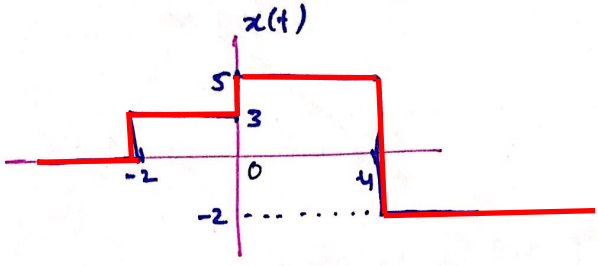
upward turn at $t=0$

downward turn at $t=1$

$$x(t) = 2\gamma(t) - 2\gamma(t-1)$$

```
t=   1:0.1:5;
for   k= 1:length(t)
      tt= t(k)
      if(tt>=0)
       y_t(k) = 2*tt;
      end
      if(tt>=1)
       y_t-1(k) = -2*tt+2;
      end
end
Plot(t, y_t + Y_t-1)
axis([-1 5  -1  3])
```

Ex



Solution: 3 discontinuities a→ at $t=-2$ (0−3)

b→ at $t=0$ (3−5)

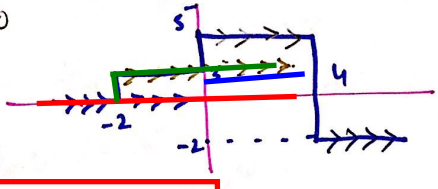
c→ at $t=4$ (5−−2)

So we can represent using 3 step signals.

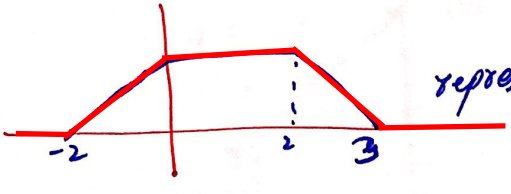
$x(t) = \boxed{0} + \boxed{3U(t+2)} + \boxed{2U(t-0)} - 7U(t-4)$

(3−0) step shifted left (5−3) (5−(−2))

upward switching at $t=-2$; at $t=0$; downward switching at $t=4$



$$x(t) = 3U(t+2) + 2U(t) - 7U(t-4)$$

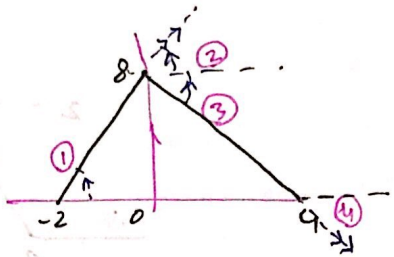
Q: 

represent ?

H.W

Represent the waveform mathematically?

Q



$$x(t) = 0 + \underset{①}{\frac{8}{2}}\gamma(t+2) - \underset{②}{\frac{8}{2}}\gamma(t-0) - \underset{③}{\frac{8}{4}}\gamma(t-0)$$

$$+ \underset{④}{\frac{8}{4}}\gamma(t-4)$$

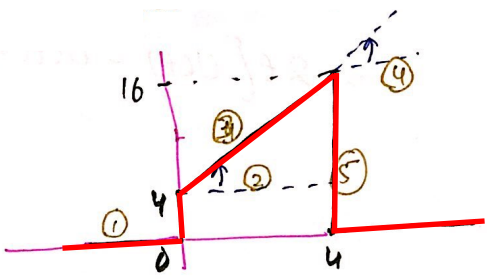
$$= 4\gamma(t+2) - 4\gamma(t) - 2\gamma(t) + 2\gamma(t-4)$$

$$= 4\gamma(t+2) - 6\gamma(t) + 2\gamma(t-4)$$

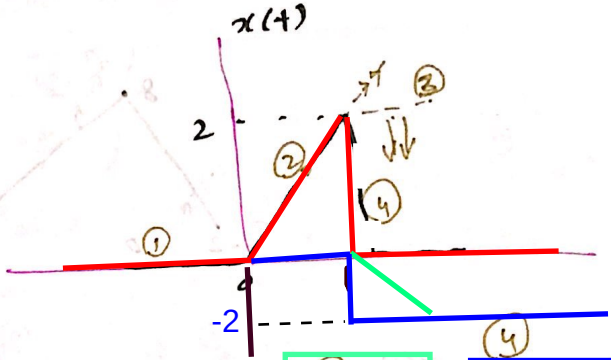
tmp => Whenever there is a turn from one slope to an other slope then first we'll have to settle down to a constant vvalue and then to the next slope

Q:

H.W



$$x(t) = \underset{①}{0} + \underset{②}{4u(t-0)} + \underset{③}{\frac{12}{4}}\gamma(t-0) - \underset{④}{\frac{12}{4}}\gamma(t-4) - 16u(t-4)$$



$$x(t) = \underset{①}{0} + \underset{②}{2r(t-0)} - \underset{③}{2r(t-1)} - \underset{④}{2u(t-1)}$$

$$\boxed{x(t) = 2r(t) - 2r(t-1) - 2u(t-1)}$$

We can also write

$$r(t) = t \cdot u(t)$$

So

$$x(t) = 2 \cdot t \cdot u(t) - 2(t-1)u(t-1) - 2 \cdot u(t-1)$$

$$= 2t\,u(t) - 2t\,u(t-1) + 2u(t-1) - 2u(t-1)$$

$$= 2t\,u(t) - 2t\,u(t-1)$$

$$= 2t\left[u(t) - u(t-1)\right]$$