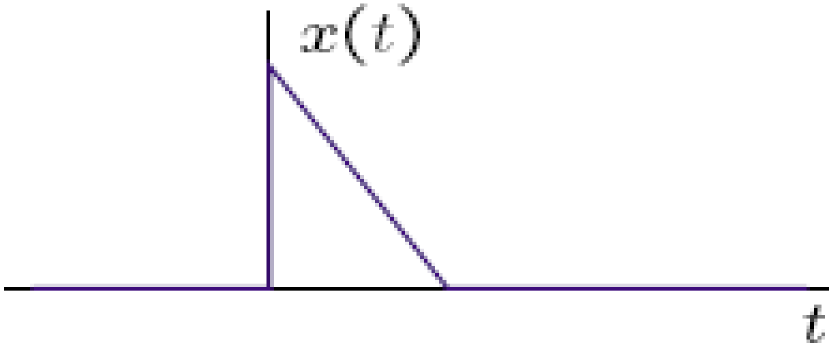
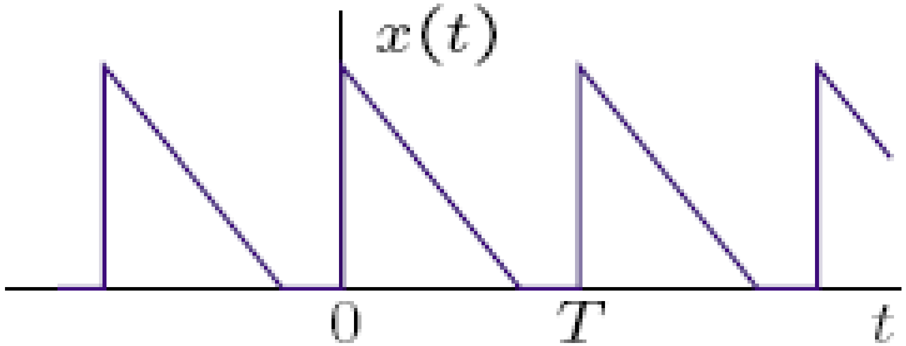
GENERAL CHARACTERISTICS OF SIGNALS

- <u>PERIODIC OR APERIODIC SIGNAL</u> A signal is said to be periodic if it can be described by the equation as $f(t) = f(t \pm kT)$ $k = 0, 1, 2, \ldots$ Where T is the period of the signal . The sine wave , sin t , is periodic with period $T = 2\pi$. Another example of periodic signal is the Square Wave .
- Signals like pulses (rectangular , triangular) are not periodic because the pulse patterns do not repeat after certain finite interval T

- Periodic signals have the property that $x(t + T) = x(t)$ for all t.
- The smallest value of T that satisfies the definition is called the *period*.
- Shown below are an aperiodic signal (left) and a periodic signal (right).





ENERGY AND POWER SIGNALS

- Energy signal : An energy signal is a signal which has a finite energy and zero power.

X (t) will be an energy signal if

$0 < E < \infty$ E is Energy

and $P = 0$ P is Power

- Power Signal : A power signal is one which has finite average power and infinite energy.

$0 < P < \infty$ and $E = \infty$

- If signal does not satisfy any of the above conditions ,

then it is neither an energy nor a power signal.

ENERGY AND POWER SIGNALS (contd)

- Energy signal is given by :-
- $$E = \sum_{-\infty}^{\infty} | x(n) |^2 \rightarrow \text{discrete signal}$$

$$E = \sum_{t=-\infty}^{\infty} | x(t) |^2 \rightarrow \text{continuous signal}$$

- Power signal is given by :-
- $$P = (1/T_0) \int_{-T_o/2}^{T_o/2} | x^2(t) | \, dt$$

where T_o is Time period

DIFFERENCES BETWEEN ENERGY AND POWER SIGNALS

S.No	Energy signal	Power Signal
1	Total normalised energy is finite and non zero.	The normalised average power is finite and non-zero.
2.	The energy is given by $E = \int_{-\infty}^{\infty} \lvert x(t) \rvert^2 \, dt$	The average power is given by $P = \lim_{T \to \infty} (1/T_0) \int_{-T_o/2}^{T_o/2} \lvert x^2(t) \rvert \, dt$

DIFFERENCES BETWEEN ENERGY AND POWER SIGNALS

S.No	Energy signal	Power Signal
3	Non periodic signals are energy signals	Periodic signals are power signals.
4	These signals are time limited.	These signals can exist over infinite – time.
5	Power of energy signal is zero.	Energy of power signal is infinite.
6.	Ex.:- A single rectangular pulse	Ex. :- A periodic pulse train

Example on Power / Energy Signal

- $X(n) = (½)^n u(n)$
- $E(\infty) = \sum_{n=-\infty}^{\infty} | x(n) |^2$
- $E(\infty) = \sum_{n=0}^{\infty} | 1/2)^n |^2 = 1 + (½)^2 + (1/2)^4 + (½)^6 + (1/2)^8 + - - -$

$= 1 / [1 - (1/2)^2] = 4/3$

Power is zero since if the energy of the signal is finite then power is zero.

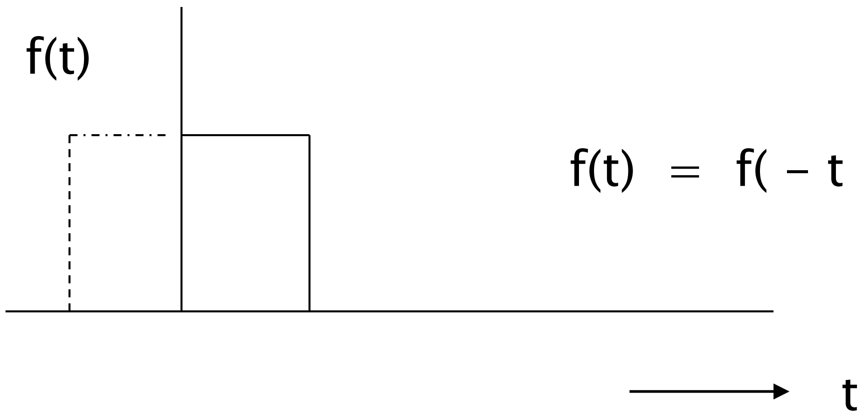
GENERAL CHARACTERISTICS OF SIGNALS (C0NTD)

- **SYMMETRY PROPERTY OF SIGNALS**
- The key words here are EVEN and ODD .A signal function can be **EVEN** or **ODD** or **NEITHER.**
- An Even function obeys the relation $f(t) = f(-t)$

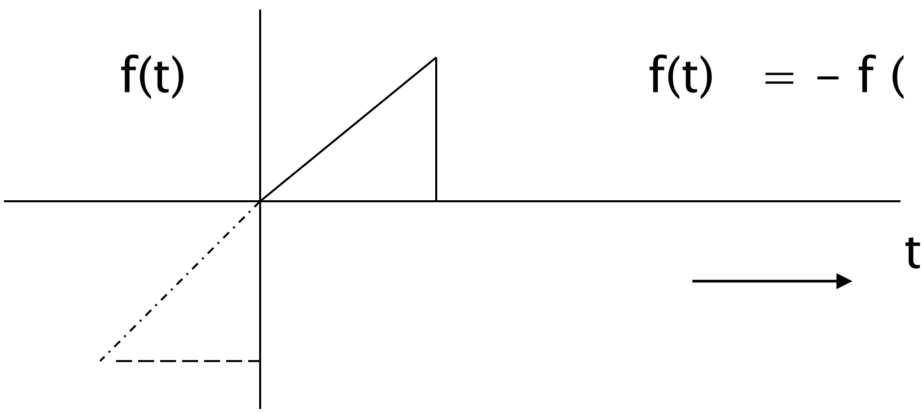
  For an Odd function $f(t) = -f(-t)$

- For example ,the function sin t is odd , and the function cos t is even .
- A signal function need not be even or odd .

- As shown the square pulse is even and triangular pulse is odd .



$f(t) = f(-t)$



$f(t) = -f(-t)$

GENERAL CHARACTERISTICS OF SIGNALS (CONTD)

- Any signal $f(t)$ can be resolved into an even component $f_e(t)$ and an odd component $f_o(t)$ such that

$$f(t) = f_e(t) + f_o(t) \qquad (1)$$

$$f(-t) = f_e(-t) + f_o(-t)$$

$$= f_e(t) - f_o(t) \qquad (2)$$

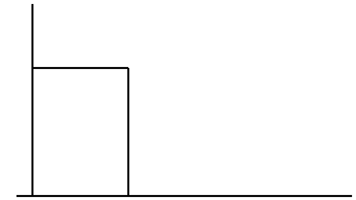
Therefore the odd and even parts of the signal can be

$$f_e(t) = \tfrac{1}{2}\,[\, f(t) + f(-t)\,]$$

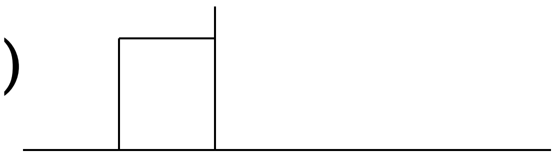
$$f_o(t) = \tfrac{1}{2}\,[\, f(t) - f(-t)\,]$$

Ex : Resolve the given signal into even and odd parts

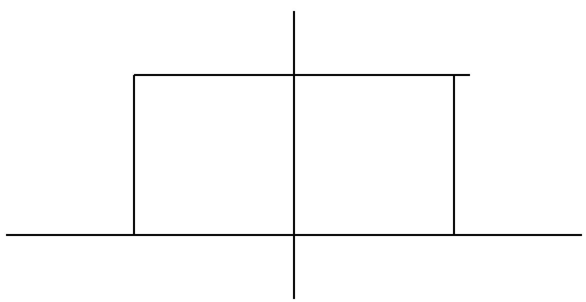
Given f(t) =



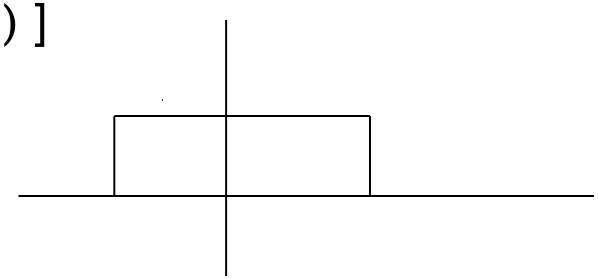
then f(– t) =



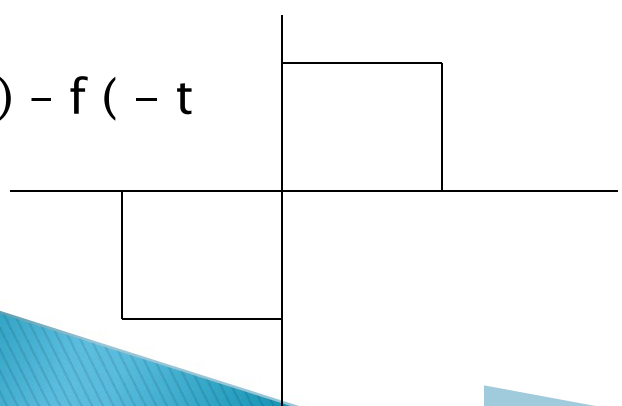
f (t) + f (– t)



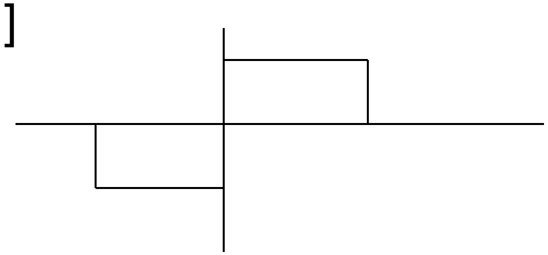
$f_e(t) = ½ [f(t) + f (– t)]$

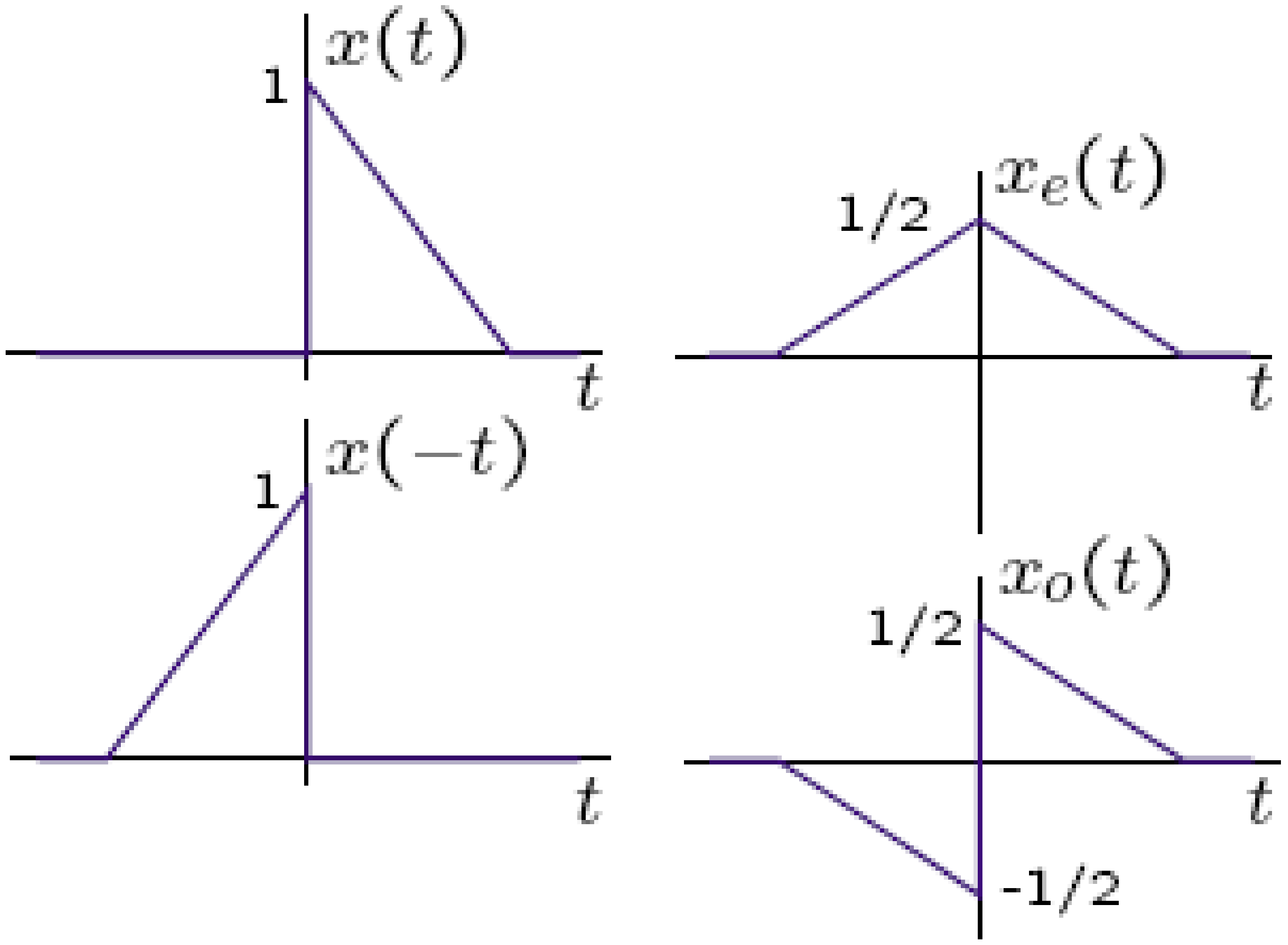


f (t) – f (– t)



$f_o (t) = ½ [f (t) – f (– t)]$

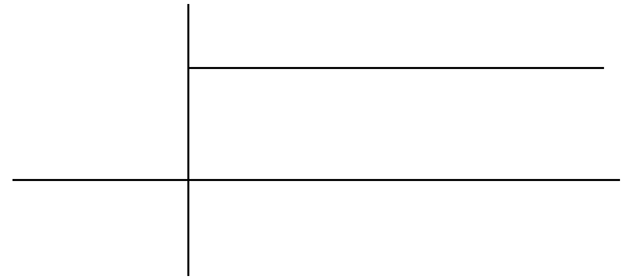




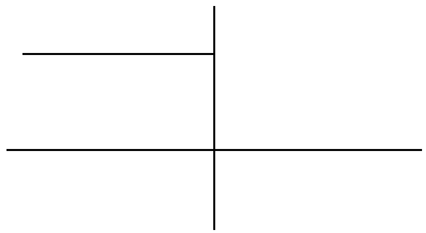
$x(t)$
1
t
$x(-t)$
1
t
$x_e(t)$
1/2
t
$x_o(t)$
1/2
t
-1/2

Ex : Resolve the given signal into even and odd parts

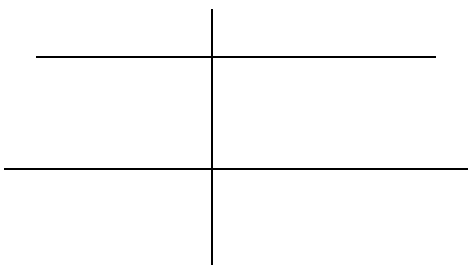
- Given $f\ (t)$ as



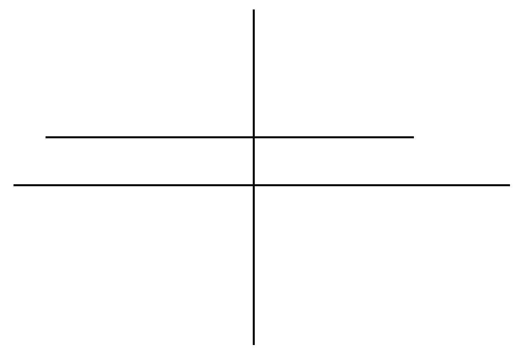
Then $f(-t) =$



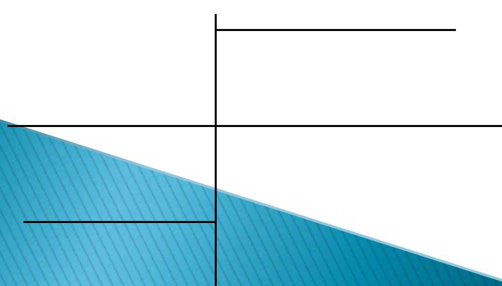
$f(t) + f(-t)$



$f_e(t) = \frac{1}{2}[f(t) + f(-t)]$



$f(t) - f(-t)$



$f_o(t) = \frac{1}{2}[f(t) - f(-t)]$