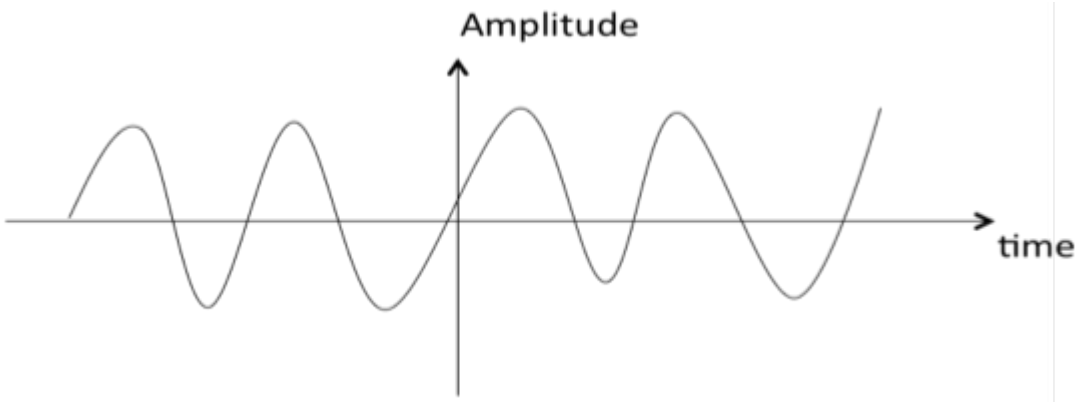
SIGNALS CLASSIFICATION

Signals are classified into the following categories:

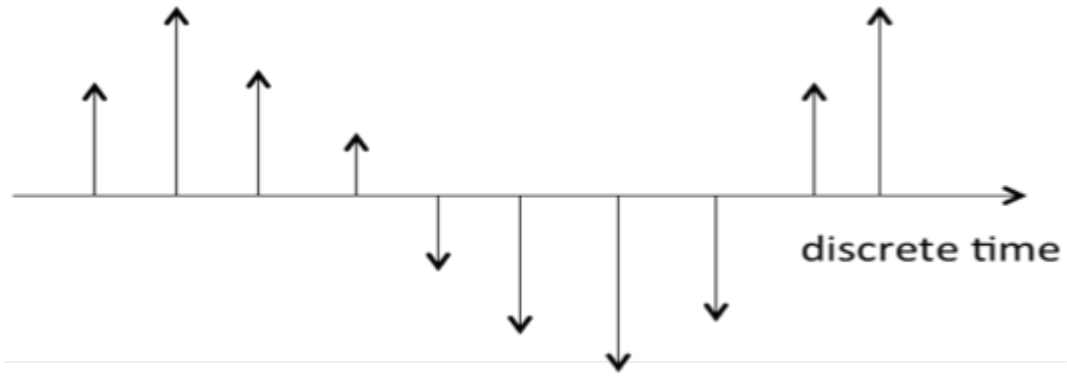
- Continuous Time and Discrete Time Signals
- Deterministic and Non-deterministic Signals
- Even and Odd Signals
- Periodic and Aperiodic Signals
- Energy and Power Signals
- Real and Imaginary Signals

Continuous Time and Discrete Time Signals

A signal is said to be continuous when it is defined for all instants of time.

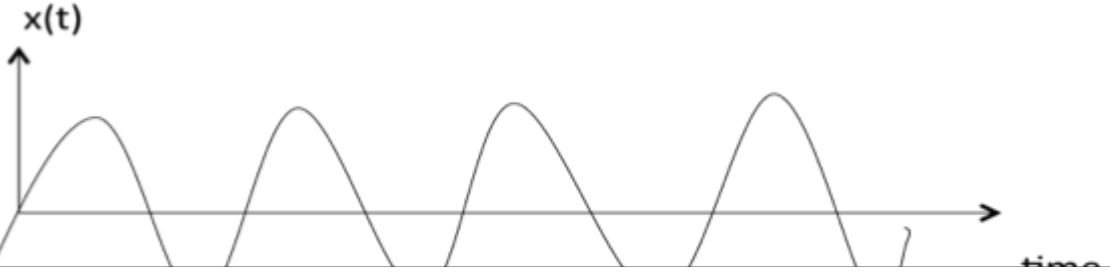


A signal is said to be discrete when it is defined at only discrete instants of time/

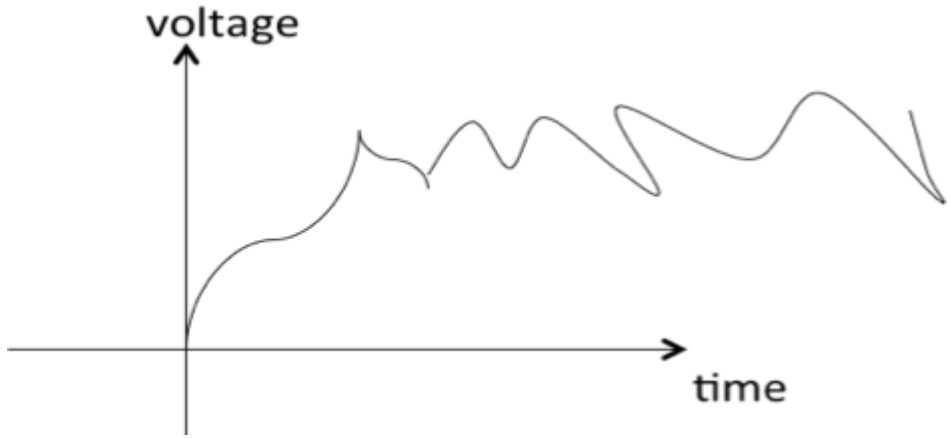


Deterministic and Non-deterministic Signals

A signal is said to be deterministic if there is no uncertainty with respect to its value at any instant of time. Or, signals which can be defined exactly by a mathematical formula are known as deterministic signals.



A signal is said to be non-deterministic if there is uncertainty with respect to its value at some instant of time. Non-deterministic signals are random in nature hence they are called random signals. Random signals cannot be described by a mathematical equation. They are modelled in probabilistic terms.



Even and Odd Signals

A signal is said to be even when it satisfies the condition xt = x$-t$

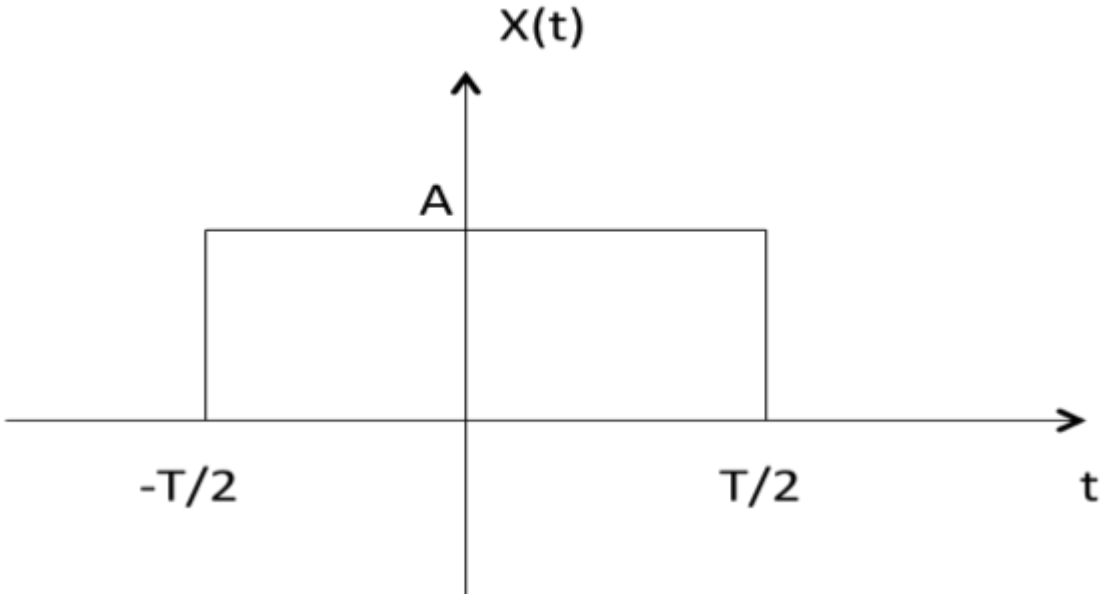
Example 1: t2, t4… cost etc.

Let xt = t2

x$-t$ = $-t$2 = t2 = xt

∴, t2 is even function

Example 2: As shown in the following diagram, rectangle function xt = x$-t$ so it is also even function.



A signal is said to be odd when it satisfies the condition xt = -x$-t$

Example: t, t3 ... And sin t

Let xt = sin t

x$-t$ = sin$-t$ = -sin t = -xt

∴, sin t is odd function.

Any function ft can be expressed as the sum of its even function $f_e t$ and odd function $f_o t$.

$f(t) = f_e(t) + f_0(t)$

where

$f_e(t) = ½[f(t) + f(-t)]$

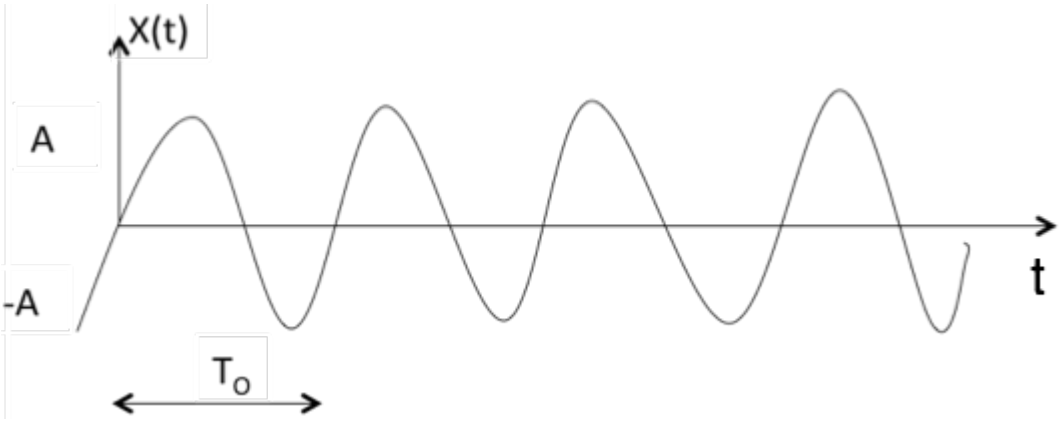
Periodic and Aperiodic Signals

A signal is said to be periodic if it satisfies the condition $xt = xt + T$ or $xn = xn + N$.

Where

T = fundamental time period,

1/T = f = fundamental frequency.



The above signal will repeat for every time interval T_0 hence it is periodic with period T_0.

Energy and Power Signals

A signal is said to be energy signal when it has finite energy.

$$\text{Energy } E = \int_{-\infty}^{\infty} x^2\,(t)dt$$

A signal is said to be power signal when it has finite power.

$$\text{Power } P = \lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} x^2(t)dt$$

NOTE:A signal cannot be both, energy and power simultaneously. Also, a signal may be neither energy nor power signal.

Power of energy signal = 0

Energy of power signal = ∞

Real and Imaginary Signals

A signal is said to be real when it satisfies the condition $xt = x^*t$

A signal is said to be odd when it satisfies the condition $xt = -x^*t$

Example:

If xt= 3 then x^*t=3*=3 here xt is a real signal.

If xt= 3j then x^*t=3j* = -3j = -xt hence xt is a odd signal.

Note: For a real signal, imaginary part should be zero. Similarly for an imaginary signal, real part should be zero.