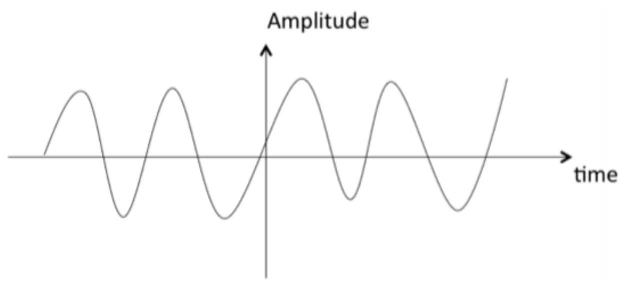
Classification of Signals

Signals are classified into the following categories:

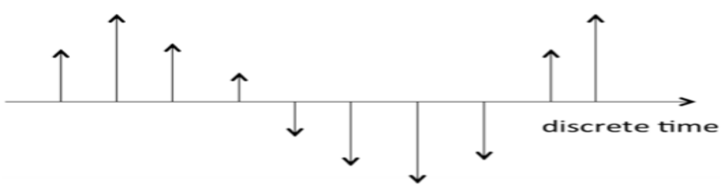
- Continuous Time and Discrete Time Signals
- Deterministic and Non-deterministic Signals
- Even and Odd Signals
- Periodic and Aperiodic Signals
- Energy and Power Signals
- Real and Imaginary Signals

Continuous Time and Discrete Time Signals

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

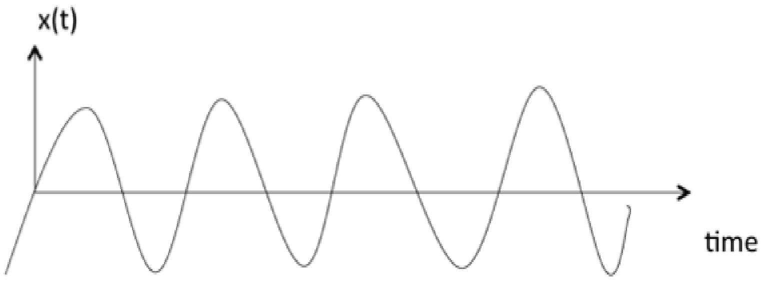


A signal is said to be discrete when it is defined at only discrete instants of time

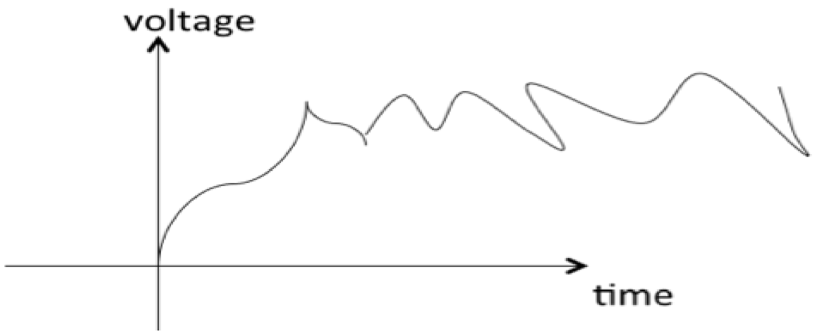


Deterministic and Non-deterministic Signals

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 signal 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 $x(t) = x(-t)$

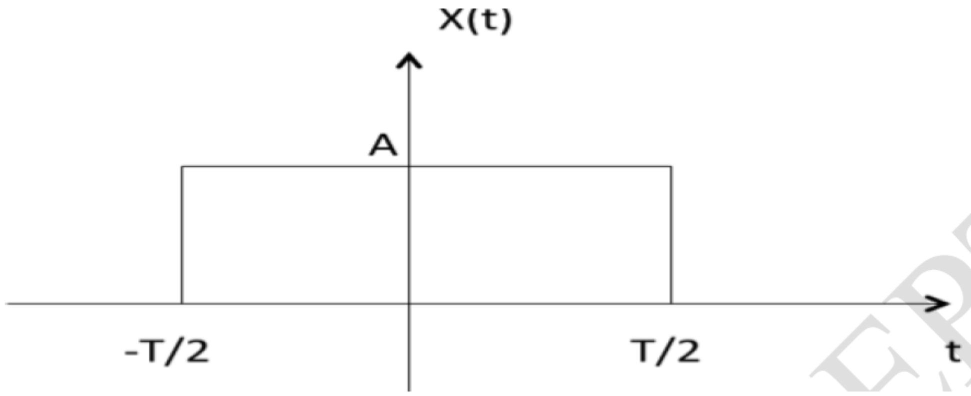
Example 1: t^2, t^4… cost etc.

Let $x(t) = t^2$

$x(-t) = (-t)^2 = t^2 = x(t)$

$\therefore t^2$ is evenfunction

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



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

Example: t, t^3 ... And sin t

Let x(t) = sin t

x(-t) = sin(-t) = -sin t = -x(t)

∴ sin t is odd function.

Any function f(t) can be expressed as the sum of its even function f_e(t) and odd function f_0(t).

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

where

$f_e(t) = ½[f(t) + f(-t)]$

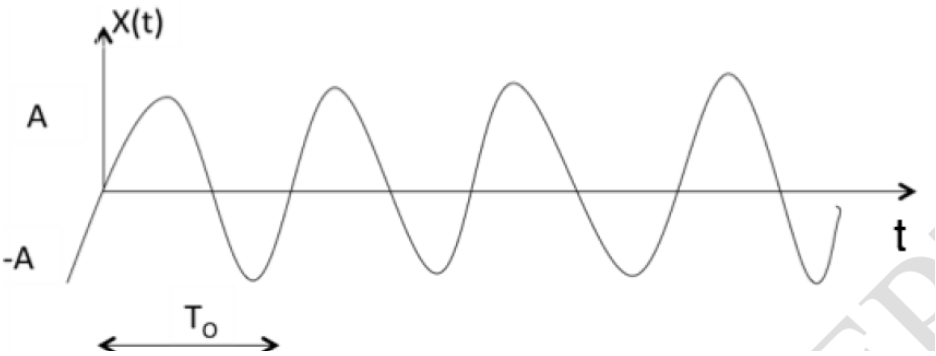
Periodic and Aperiodic Signals

A signal is said to be periodic if it satisfies the condition x(t) = x(t + T) or x(n) = x(n + N).

Where

T = fundamental time period,

1/T = f = fundamental frequency.



The above signal will repeat for every time interval T0 hence it is periodic with period T0.

Energy and Power Signals

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

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

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

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

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

Example:

If $x(t)= 3$ then $x^*(t)=3^*=3$ here $x(t)$ is a real signal.

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

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