Classification of Signals

Signals are classified in to two type:

1. Continuous Time signal
2. Discrete Time Signal

They are further classified into

i. Deterministic or Random Signal
ii. Periodic or Aperiodic Signals
iii. Energy or Power Signals
iv. Causal or Non-causal signal
v. Even or Odd signals

ii. Periodic or Aperiodic Signals

A continuous time signal x(t) is said to be periodic if it satisfies,

$$x(t+T) = x(t) for\ all\ t$$

Then it is called periodic signal otherwise it is called Aperiodic signals.

Ex:

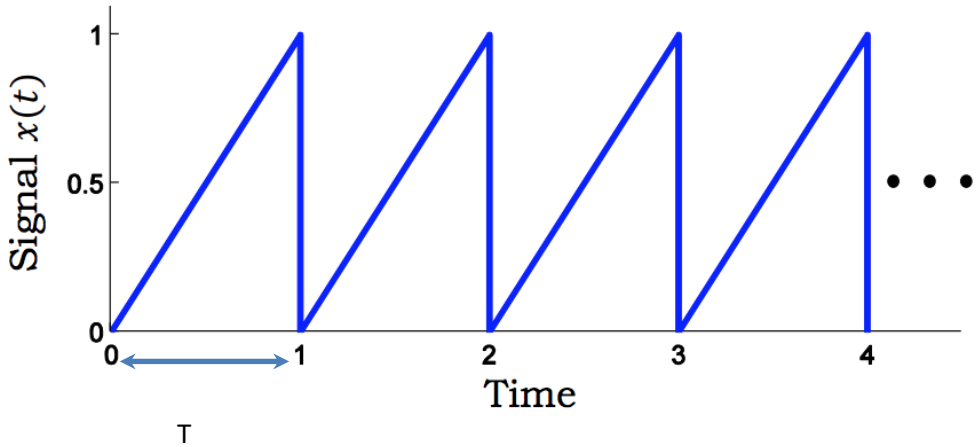
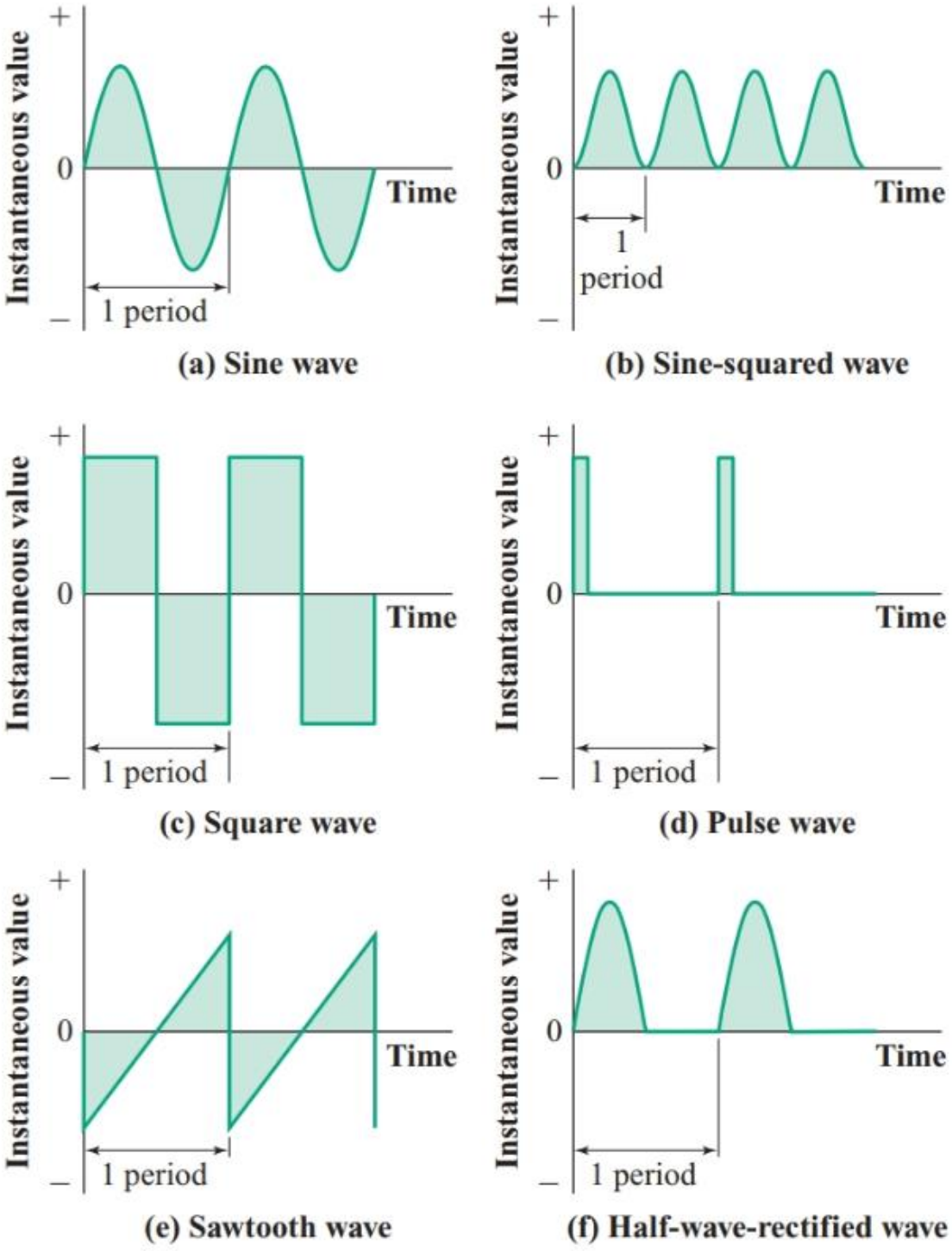


Figure 1: **Sawtooth wave**

T =1

The smallest value of T, time period, which satisfies the above equation, is called “Fundamental period” or “Time Period”. i.e after the fundamental period the pattern of the waveform will repeat itself.



A discrete time signal x[n] is said to be periodic if it satisfies,

X[n+N]=x[n] for all 'n', otherwise it is called aperiodic signal.

Where N= 'Fundamental period' or 'time period'.

Q 1. Find the fundamental period of

$\boldsymbol{x(t) = A\sin(\omega_0 t) + \theta}$

Solution:

$x(t) = A\sin(\omega_0 t + \theta)$

$x(t+T) = A\sin(\omega_0(t+T) + \theta) = A\sin(\omega_0 t + \omega_0 T + \theta)$

We need to prove x(t) = x(t+T), where T is the fundamental period.

Let $\omega_0 T = 2\pi$

$x(t+T) = A\sin(2\pi + \omega_0 T + \theta)$

$\sin(2\pi + \theta) = sin\theta$

$=> x(t+T) = A\sin(\omega_0 T + \theta) = x(t)$,

The fundamental period is $\boldsymbol{T = \frac{2\pi}{\omega_0}}$.

<u>Energy or Power Signals:</u>

Energy Signal: A continuous or discrete time signal said to be energy signal, if its energy is finite and power is zero.

i.e. $0 < E < \infty$; $P = 0$

Unit of Energy: Joules

Power: Rate of change of energy

Energy calculation for continuous time signal:

$E = \int_{-\infty}^{\infty} x^2(t)dt$, for real valued signals

$E = \int_{-\infty}^{\infty} |x(t)|^2 dt$, for complex valued signals

Energy calculation for discrete time signals:

$$E = \sum_{n=-\infty}^{\infty} |x[n]|^2$$

Ex: Find energy of signal

n	**0**	**1**	**2**	**3**
x[n]	**1**	**2**	**3**	**4**

Solution:

$E = 1^2 + 2^2 + 3^2 + 4^2 = 30\ J$

Note: All finite duration signals are energy signals.

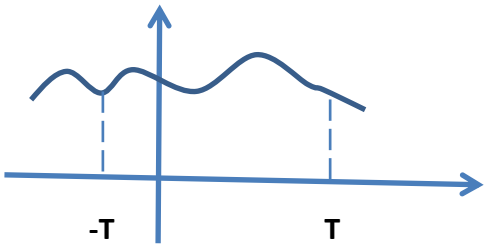
Power Signals:

A continuous or discrete time signal is said to be power signal if its power is finite and energy is infinite.

i.e. $0 < P < \infty$; $E = \infty$

Example: All periodic signals are power signals.

Q1.



Power:

For continuous signal,

$P = \lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} x^2(t)dt$ for real valued signals

$P = \lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} |x(t)|^2 dt$ for complex valued signals

For Discrete signal,

$$P = \lim_{N\to\infty} \frac{1}{2N+1} \sum_{n=-N}^{N} |x[n]|^2$$

Unit of power: watts