Introduction :

- A major concern of the physical layer is moving information in the form of electromagnetic Signals across a transmission medium.

- Encoder create a stream of 1's and 0s that tells the receiving device how to reconstruct data to its original form.

- even 1s and 0s cannot be sent as such across network links. They must be further converted into a form that transmission media can accept.

- Data stream of 1s and 0s must be turned into energy in the form of electromagnetic signal.

Analog And Digital :-

- Both Data and the signals that represent them can take either analog or digital form.

- Analogue refers to something that is continuous [a set of specific point of data and all possible points between them.

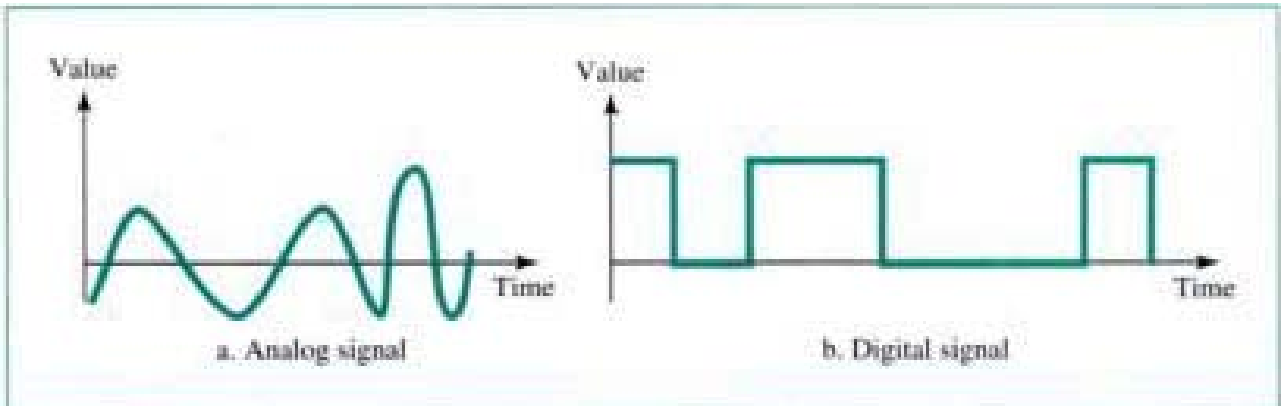
- Digital refers to something that is discrete.

- An analog signal is continuous wave from that changes smoothly over time [include infinite number of values].

- A digital signal, is discrete [it can have only a limited number of defined values, often as 1,0].

- Signals represented by plotting them on a pair of perpendicular axes. The vertical axis represents the value or strength of a signal. The horizontal axis represents the time.

- Figure illustrates comparison between analog and digital.



- Analog signal changes continuously with respect to time, while the digital signal changes instantaneously.

Signals can be analog or digital. Analog signals can have an infinite number of Values in a range; digital signals can have only a limited number of values.

- Aperiodic And Periodic Signal :-

Both analog and digital signal can be of two forms periodic and aperiodic (nonperiodic) . A periodic signal completes a pattern within a measurable time frame, called a period (T), and repeats that pattern over subsequent identical periods. The completion of one full pattern is called a cycle. A nonperiodic signal changes without exhibiting a pattern or cycle that repeats over time.

Both analog and digital signals can be periodic or nonperiodic. In data communications, we commonly use periodic analog signals (because they need less bandwidth, and nonperiodic digital signals (because they can represent variation in data.

An aperiodic signals can be decomposed into an infinite number of periodic signals.

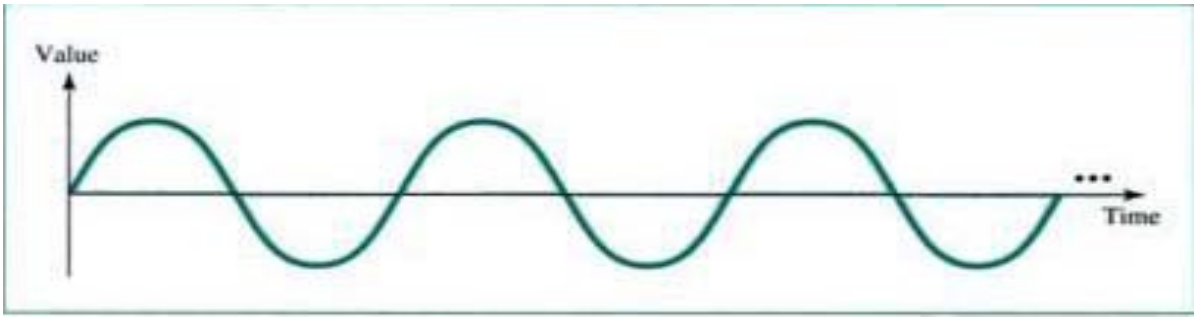
- Periodic Analog Signals :-

Periodic analog signals can be classified as simple or composite. A simple periodic analog signal, a sine wave, cannot be decomposed into simpler signals. A composite periodic analog signal is composed of multiple sine waves.

Sine Wave

The sine waves are the most fundamental form of a periodic analog signal.

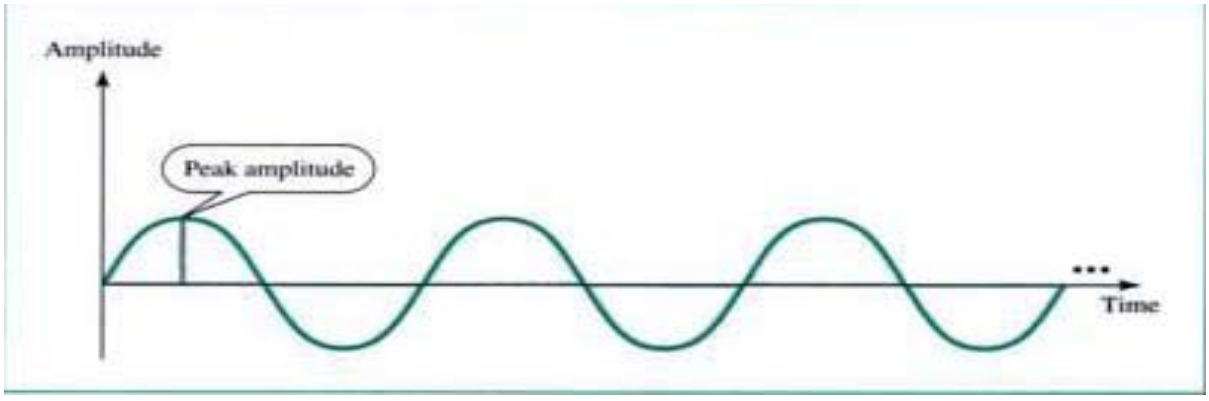
Sine wave can be fully describes by three characteristics.
Peak amplitude, **period or frequency** and **phase**.



Sine Wave

Peak Amplitude :-

The peak amplitude of a signal is the absolute value of its highest intensity, proportional to the energy it carries. For electric signals, peak amplitude is normally measured in volts.



Peak amplitude

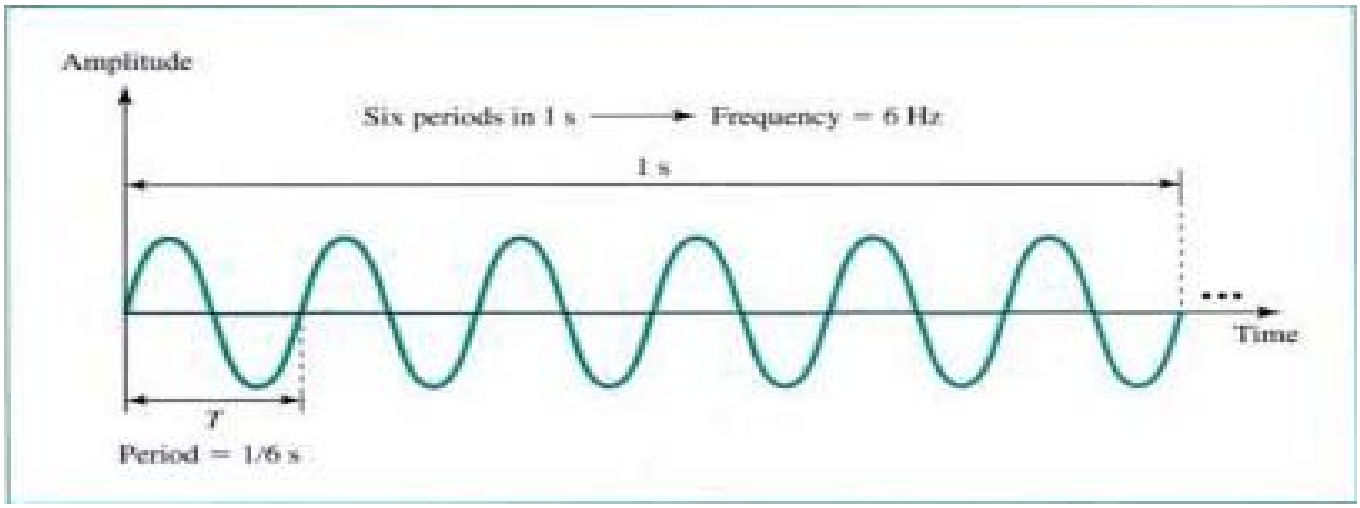
Period and Frequency :-

Period : is the amount of time (in seconds) it takes a signal to complete one cycle.

Frequency : is the number of cycle per second.

- ✓ Frequency and period are inverse of each other :

  f = 1 / T and T= 1 / f



Frequency and Period

- ✓ Frequency is expressed in Hertz (Hz).
- ✓ Period is expressed in seconds.

Unit	*Equivalent*	*Unit*	*Equivalent*
Seconds (s)	1 s	hertz (Hz)	1 Hz
Milliseconds (ms)	10^{-3} s	kilohertz (KHz)	10^{3} Hz
Microseconds (µs)	10^{-6} s	megahertz (MHz)	10^{6} Hz
Nanoseconds (ns)	10^{-9} s	gigahertz (GHz)	10^{9} Hz
Picoseconds (ps)	10^{-12} s	terahertz (THz)	10^{12} Hz

Example :

The power we use at home has a frequency of 60 Hz (50 Hz in Europe). The period of this sine wave can be determined as follows:

T = 1 / f → 1 / 60 = 0.0166 S = 0.0166 × 103 ms = 16.6 ms

This means that the period of the power for our lights at home is 0.0116 s, or 16.6 ms.
Our eyes are not sensitive enough to distinguish these rapid changes in amplitude.

Ex : A sine wave has a frequency of 8 KHz. What its period?

$T = 1 / f = 1 / 8000 = 0.000125\ S = 125\ \mu s$

Ex : A sine wave complete one cycle in 25 μs what is its frequency ?

$f = 1 / T \rightarrow 1 (25 * 10^{-6}) = 40{,}000 = 40\ KHz$

Express a period of 100 ms in microseconds.

If a signal does not change at all, its frequency is zero.

If a signal changes instantaneously, its frequency is infinite.

Phase:-

The term phase describes the position of the wave from relative to time zero.

If we think of the waves as something that can be shifted backward along the time axis, phase describe the amount of that shift. It indicates the statues of the first cycle.

- Phase is measured in degree.