Data Communications and Computer Networks

Introduction:

Communication implies an exchange of information between at least two parties, this exchange may be in the form of words, letters, messages, drawings, body movements, voice, pictures, or any other symbols to represent the ideas we wish. Communication also suggests a system of paths through which information travels from party to party.

People need to communicate; computer users are no exception, i.e. people need to transmit and receive data through data communication. In today world, data refer to facts, statistics, pictures, voice, and other information that is digitally coded. Data communication systems transmit data over communication links between one or more computer systems.

These communication links can range from simple telephone connections to complex communications control computers.

The integration (marriage) of computers and communications has broadened the scope of the role of information systems. The effect of this marriage is laying in foundation for the information superhighway: which is a high speed digital communications networks that are national or worldwide. The most well known and easily implementation of information superhighway is the Internet.

To understand data communication we need to understand communication media, communication hardware, and communication networks.

Communications Principles:

Signals:

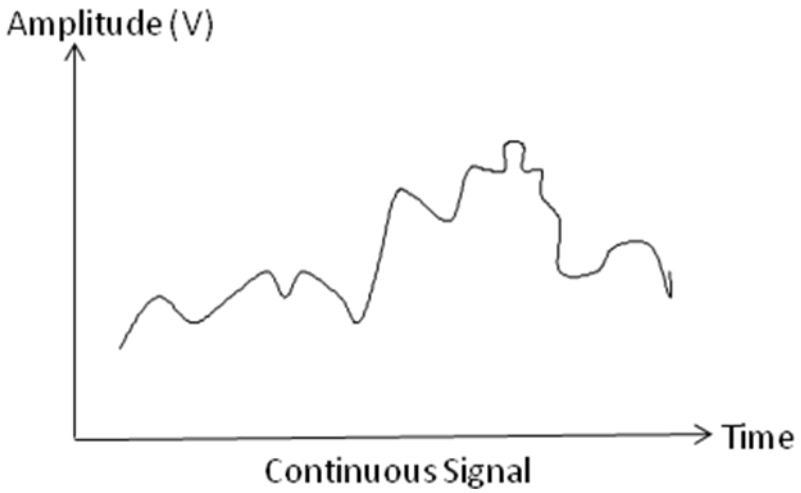
The signal is a function of time, but it can also be expressed as a function of a frequency. The signal consists of components of different frequencies. Therefore, frequency domain view of a signal is more important to understand data transmission than time domain.

Time-Domain Concepts:

As a function of time, an electromagnetic signal can be either continuous or discrete.

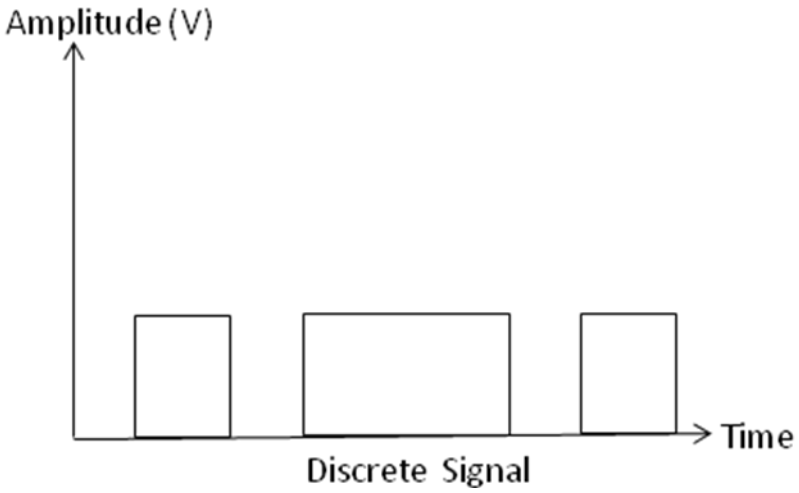
Continuous Signal

A continuous signal is one in which the signal intensity varies in smooth fashion over time. In other words, there are no breaks or discontinuities in the signal.



Discrete Signal

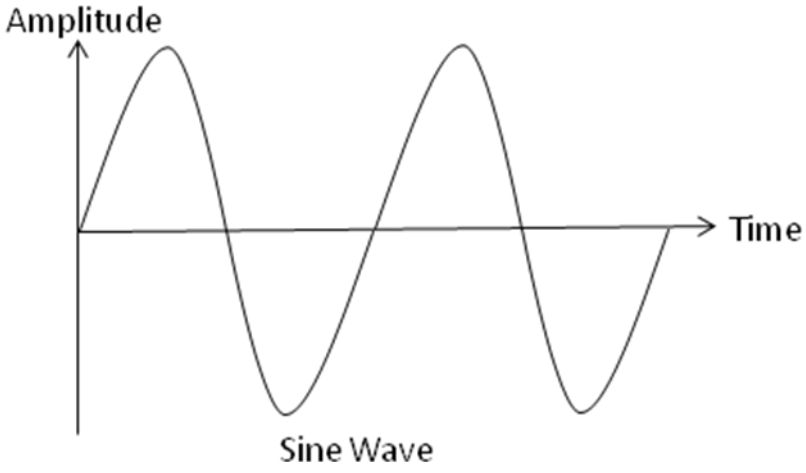
A discrete signal is one in which the signal intensity maintains a constant level for some period of time and then changes to another constant level as shown in figure below:

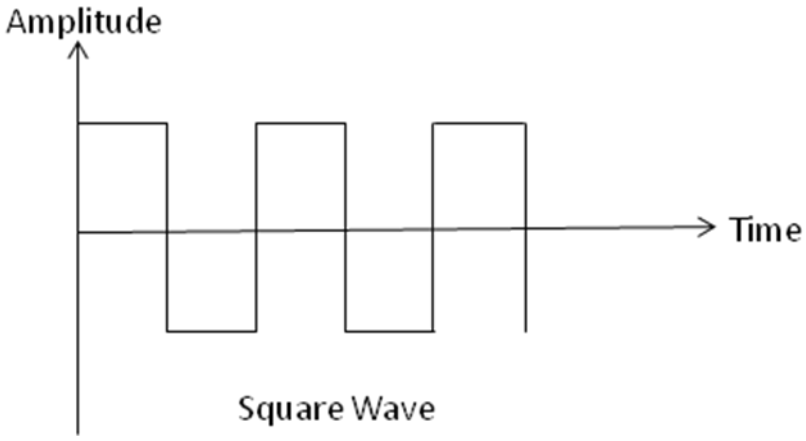


Types of Signals

1-Periodic Signal:

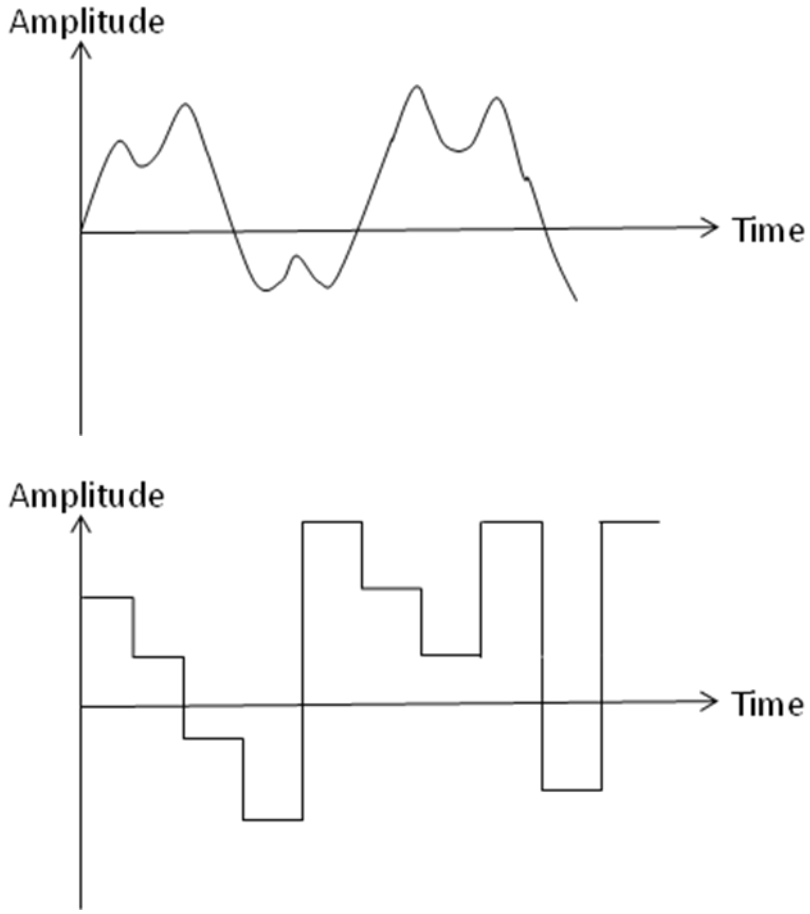
Simplest sort of signals in which the same signal pattern repeats overtime, as shown in sine or square waves:





2- **A periodic (Non Periodic) Signal**:

A periodic or non periodic signal changes constantly without repeating the same signal pattern over time as shown below:



<u>Properties of Signals</u>:

The general signal wave can be represented by three properties:

1-Peak Amplitude (A):

It is the maximum value or strength of the signal over time, this value is measured in (volts).

2-Frequency (*f*):

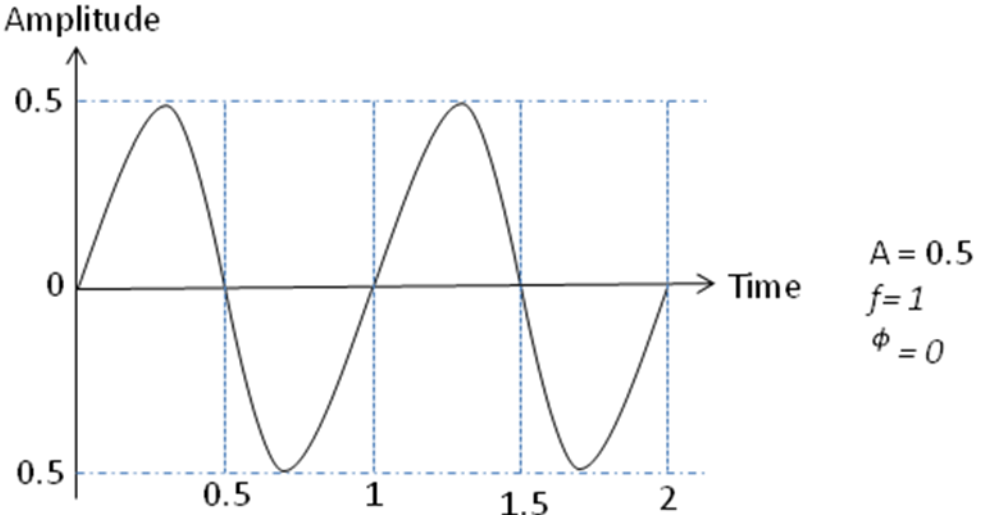
It is the rate (in cycles per second or (Hz)) at which the signal repeats. An equivalent to frequency the Period (T): which is the amount of time it takes for one repetition, therefore

$$T = 1/f$$

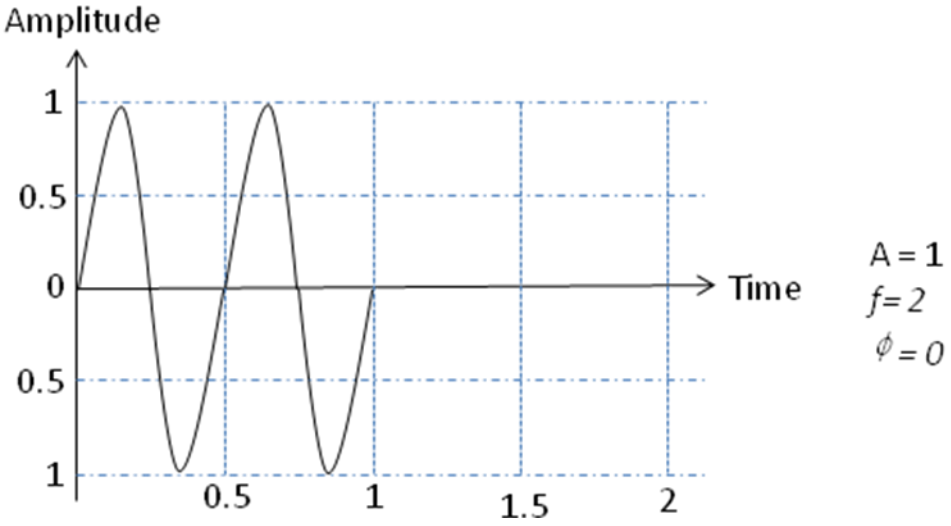
3-Phase (ϕ):

It is the position of the waveform relative to time zero.

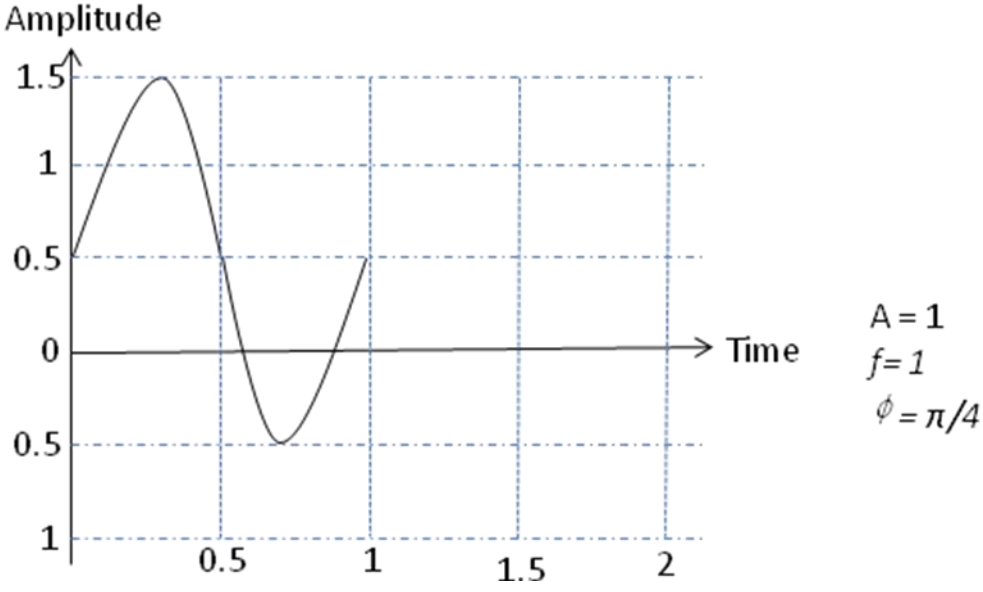
For example:



A = 0.5
f = 1
$\Phi = 0$



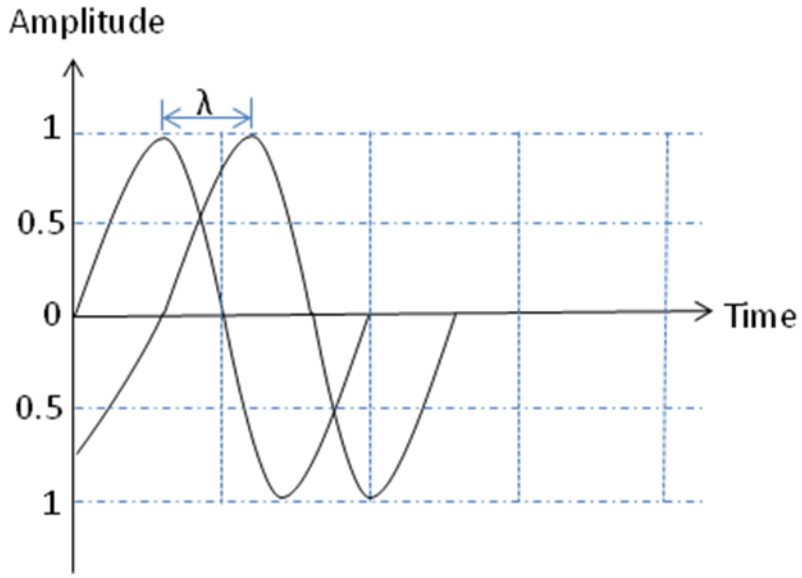
A = 1
f = 2
$\phi = 0$



A = 1
f = 1
$\phi = \pi/4$

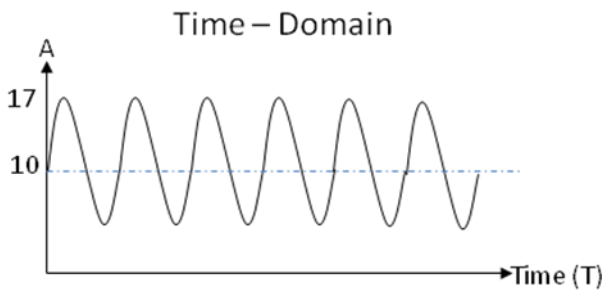
Note: There is simple relationship between the two sine waves, which is the wave length (λ).

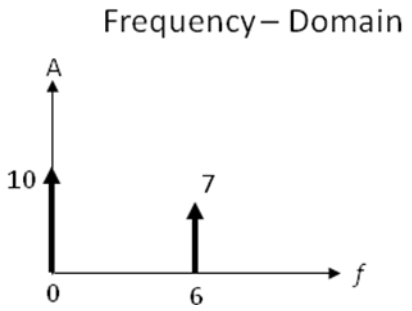
Wave length (λ): The distance between two points of corresponding phase of two consecutive cycles.

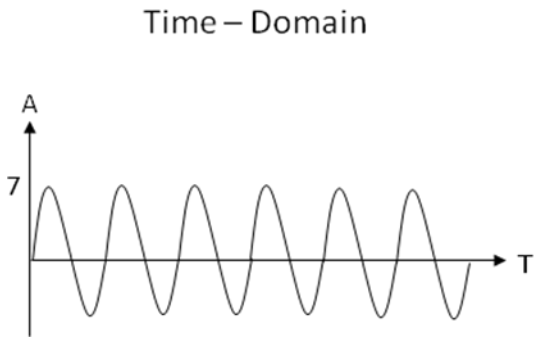


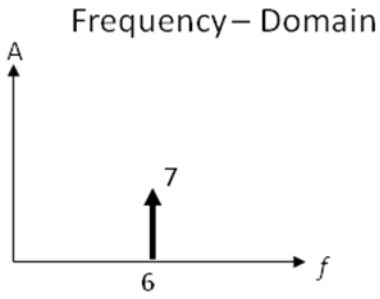
Complex Signals:

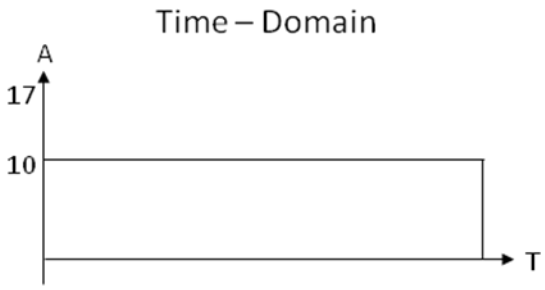
Sine waves are simple periodic signals. But there are periodic signals that are not sine waves; these waves are called complex signals. Complex signal can be decomposed into a collection of sine waves. To decompose a composite signal into its components, Fourier analysis is needed. However, the concept of decomposition can be seen with a simple example:

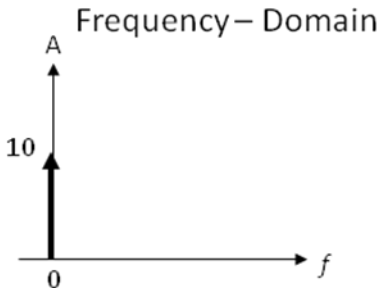












Notes:

Two terms need to mention here:

1- Frequency Spectrum of Signal: Is the combination of all sine wave signals that make that signal.

2- Band width of Signal: Is the width of the frequency spectrum.

Example:

A sine wave completes one cycle in 25 μ s. What is the frequency?

Sol:

$$f = 1/T = 1/25\times10^{-6} = 40000 \text{ Hz} = 40 \text{ KHz}$$

Example:

A signal has a band width of 80 KHz. The highest frequency is 110 KHz. What is the lowest frequency?

Sol:

$$\text{B.W.} = f_2 - f_1$$

$$80 \text{ KHz} = 110 \text{ KHz} - f_1$$

$$f_1 = 110 \text{ KHz} - 80 \text{ KHz} = 30 \text{ KHz}.$$