Chapter No: 1

Fundamentals of Data Communication and Computer Network

Introduction:

Data is defined as information which is stored in the digital form.

Data communication is the process of transferring digital information between two points.

Data can be alphabets, numeric or symbols and it consists of any one or the combination of the following:

Microprocessor op-codes, control codes, user addresses, program data or data base information.

At the source or destination the data are in digital form but during the transmission it may be analog or digital.

A data communication network can be simply consisting of two computers connected to each other a public telecommunication network.

Data Communications

When we communicate, we are sharing information. This sharing can be local or remote. Between individuals, local communication usually occurs face to face, while remote communication takes place over distance. The term *telecommunication,* which includes telephony, telegraphy, and television, means communication at a distance *(tele* is Greek for "far").

The word ***data*** refers to information presented in whatever form is agreed upon by the parties creating and using the data.

Q. Define data communications.

Data communications are the exchange of data between two devices via some form of transmission medium such as a wire cable. For data communications to occur, the communicating devices must be part of a communication system made up of a combination of hardware (physical equipment) and software (programs).

Q. Describe the characteristics of data communication system.

Characteristics of Data Communication System:

The effectiveness of a data communications system depends on four **fundamental characteristics**: **Delivery**, **Accuracy**, **Timeliness**, and **Jitter**.

1. **Delivery:** The system must deliver data to the **correct destination**. Data must be received by the intended device or user and only by that device or user.

2 **Accuracy:** The system must deliver the **data accurately**. Data that have been altered in transmission and left uncorrected are unusable.

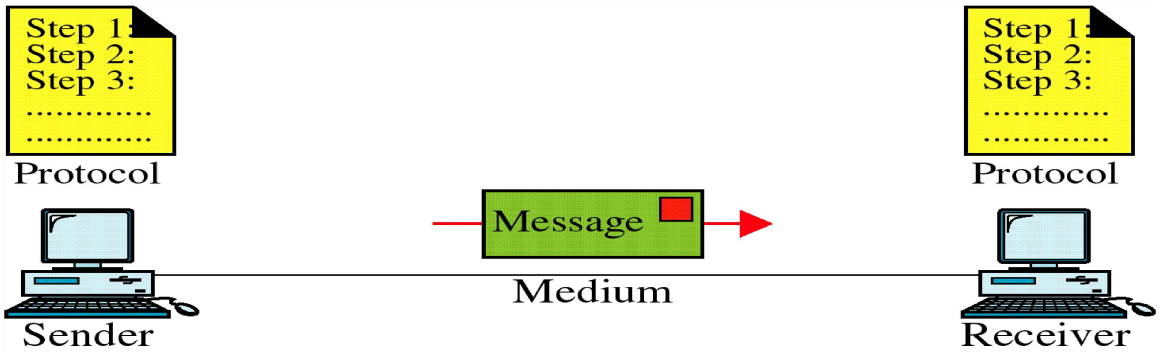
3. **Timeliness:** The system must deliver data in a **timely manner**. Data delivered late are useless. In the case of video and audio, timely delivery means delivering data as they are produced, in the same order that they are produced, and without significant delay. This kind of delivery is called *real-time* transmission.

4. **Jitter:** Jitter refers to the **variation in the packet arrival time**. It is the uneven delay in the delivery of audio or video packets. For example, let us assume that video packets are sent every

3D Ms. If some of the packets arrive with 3D-ms delay and others with 4D-ms delay, an uneven quality in the video is the result.

Q. Draw the components of data communication systems and state the function of each block.

Components of Data Communications System



A data communications system has five components:

1. **Message:** The message is the information (data) to be communicated. Popular forms of information include text, numbers, pictures, audio, and video.

2. **Sender:** The sender is the device that sends the data message. It can be a computer, workstation, telephone handset, video camera, and so on.

3. **Receiver:** The receiver is the device that receives the message. It can be a computer, workstation, telephone handset, television, and so on.

4. **Transmission medium:** The transmission medium is the physical path by which a message travels from sender to receiver. Some examples of transmission media include twisted-pair wire, coaxial cable, fiber-optic cable, and radio waves.

5. **Protocol:** A protocol is a set of rules that govern data communications. It represents an agreement between the communicating devices. Without a protocol, two devices may be connected but not communicating, just as a person speaking French cannot be understood by a person who speaks only Japanese.

Q. Explain Simplex, Half Duplex and Full Duplex communication with examples.

Communication Modes

Based on whether the system communicates only in one direction or otherwise, the communication systems are classified as

- Simplex systems
- Half duplex systems
- Full duplex systems

1. Simplex Systems

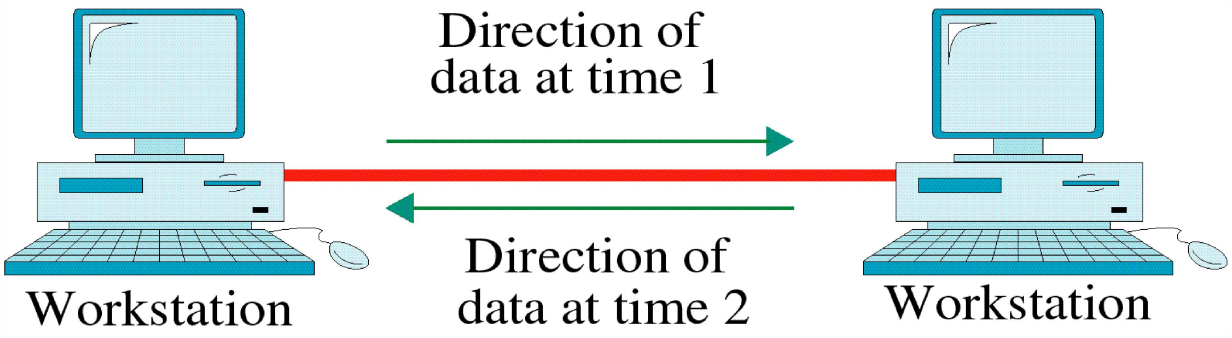
- In **Simplex** mode, the communication is unidirectional, as on a one-way street.
- Only one of the two devices on a link can transmit; the other can only receive.

- **Keyboards** and traditional **monitors** are examples of simplex devices. The keyboard can only introduce input; the monitor can only accept output.
- The simplex mode can use the entire capacity of the channel to send data in one direction.

Simplex mode of Communication

2. Half Duplex Systems

- In **Half-duplex** mode, each station can both transmit and receive, but not at the same time. :
- When one device is sending, the other can only receive, and vice versa.
- The half-duplex mode is like a one-lane road with traffic allowed in both directions. When cars are traveling in one direction, cars going the other way must wait. In a half-duplex transmission, the entire capacity of a channel is taken over by whichever of the two devices is transmitting at the time. **Walkie-talkies** and **CB (citizens band) radios** are both half-duplex systems.
- The half-duplex mode is used in cases where there is no need for communication in both directions at the same time; the entire capacity of the channel can be utilized for each direction.



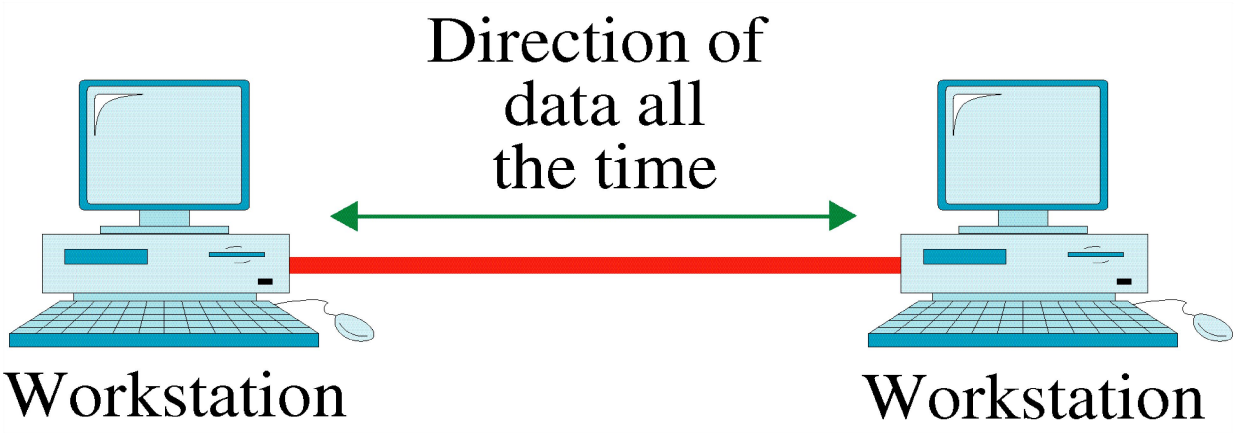
Half Duplex mode of Communication

3. Full-Duplex

- In full-duplex mode (also called duplex), both stations can transmit and receive simultaneously.
- The full-duplex mode is like a two-way street with traffic flowing in both directions at the same time. In full-duplex mode, signals going in one direction share the capacity of the link: with signals going in the other direction. This sharing can occur in two ways: Either the link must contain two physically separate transmission paths, one for sending and the other for

receiving; or the capacity of the channel is divided between signals traveling in both directions.

- One common example of full-duplex communication is the telephone network.
- When two people are communicating by a telephone line, both can talk and listen at the same time. The full-duplex mode is used when communication in both directions is required all the time. The capacity of the channel, however, must be divided between the two directions.



Full Duplex mode of Communication

Q. Define Protocols. Explain key elements of protocols.

Protocol:

- A protocol is a set of rules that govern data communications. A protocol defines what is communicated, how it is communicated, and when it is communicated.
- In computer networks, communication occurs between entities in different systems.
- An entity is anything capable of sending or receiving information. However, two entities cannot simply send bit streams to each other and expect to be understood. For communication to occur, the entities must agree on a protocol.

The key elements of a protocol are: syntax, semantics, and timing.

1) Syntax: (what is to be communicated?)

- The term *syntax* refers to the structure or format of the data, meaning the order in which they are presented.
- For example, a simple protocol might expect the first 8 bits of data to be the address of the sender, the second 8 bits to be the address of the receiver, and the rest of the stream to be the message itself.

2) Semantics: (how it is to be communicated)

- The word *semantics* refers to the meaning of each section of bits.
- How is a particular pattern to be interpreted, and what action is to be taken based on that interpretation? For example, does an address identify the route to be taken or the final destination of the message?

3) Timing: (when it should be communicated)

- The term *timing* refers to two characteristics: when data should be sent and how fast they can be sent. For example, if a sender produces data at 100 Mbps but the receiver can process data at only 1 Mbps, the transmission will overload the receiver and some data will be lost.

Q. Define Standard. Name any four Standard Organizations. Give their functions

Standards:

- Standards provide guidelines to manufacturers, vendors, government agencies, and other service providers to ensure the kind of interconnectivity necessary in today's marketplace and in international communications.

- Standards are essential in creating and maintaining an open and competitive market for equipment manufacturers and in guaranteeing national and international interoperability of data and telecommunications technology and processes.

- Data communication standards fall into two categories: *de facto* (meaning "by fact" or "by convention") and *de jure* (meaning "by law" or "by regulation").

1) **De facto:**
- Standards that have not been approved by an organized body but have been adopted as standards through widespread use are de facto standards.
- De facto standards are often established originally by manufacturers who seek to define the functionality of a new product or technology.

2) **De jure:**
- Those standards that have been legislated by an officially recognized body are de jure standards.

Standards Organizations:

- Standards are developed through the cooperation of standards creation committees, forums, and government regulatory agencies.

Standards Creation Committees:

- While many organizations are dedicated to the establishment of standards, data telecommunications in North America rely primarily on those published by the following:

1) International Organization for Standardization

- **(ISO):** The ISO is a multinational body whose membership is drawn mainly from the standards creation committees of various governments throughout the world.
- The ISO is active in developing cooperation in the realms of scientific, technological, and economic activity.

2) International Telecommunication Union-Telecommunication Standards Sector (ITU-T):

- By the early 1970s, a number of countries were defining national standards for telecommunications, but there was still little international compatibility.
- The United Nations responded by forming, as part of its International Telecommunication Union (ITU), a committee, the Consultative Committee for International Telegraphy and Telephony (CCITT).
- This committee was devoted to the research and establishment of standards for telecommunications in general and for phone and data systems in particular. On March 1, 1993, the name of this committee was changed to the International Telecommunication Union - Telecommunication Standards Sector (ITU-T).

3) American National Standards Institute (ANSI):

- The American National Standards Institute is a completely private, nonprofit corporation not affiliated with the U.S. federal government. However, all ANSI activities are undertaken with the welfare of the United States and its citizens occupying primary importance.

4) Institute of Electrical and Electronics Engineers (IEEE):

- The Institute of Electrical and Electronics Engineers is the largest professional engineering society in the world.
- International in scope, it aims to advance theory, creativity, and product quality in the fields of electrical engineering, electronics, and radio as well as in all related branches of engineering.
- As one of its goals, the IEEE oversees the development and adoption of international standards for computing and communications.

5) Electronic Industries Association (EIA):

- The Electronic Industries Association is a nonprofit organization devoted to the promotion of electronics manufacturing concerns.
- Its activities include public awareness education and lobbying efforts in addition to standards development.
- In the field of information technology, the EIA has made significant contributions by defining physical connection interfaces and electronic signaling specifications for data communication.

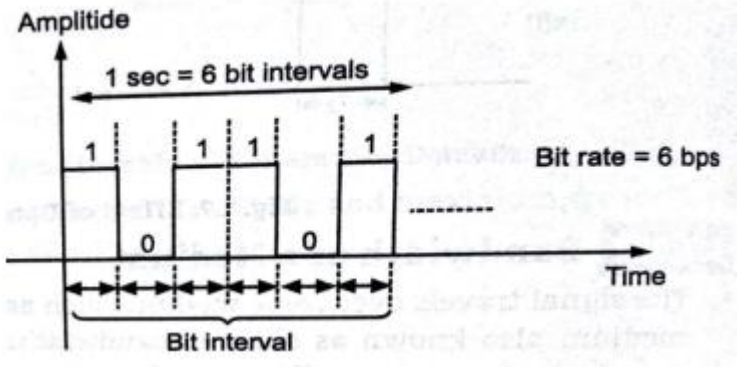
Bandwidth, Data Transmission Rate, Baud Rate and Bits Per Second

Bandwidth is measured as the amount of data that can be transferred from one point to another within a network in a specific amount of time. Typically, bandwidth is expressed as a bitrate and measured in bits per second (bps).

The term bandwidth refers to the transmission capacity of a connection and is an important factor when determining the quality and speed of a network or the internet connection.

Definition of Bit Rate

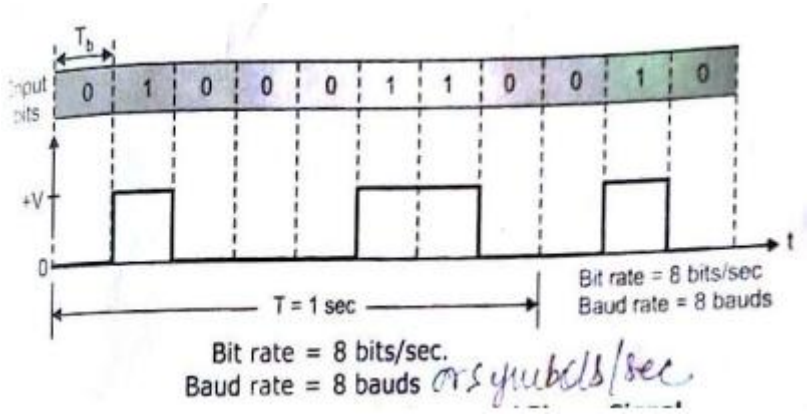
Bit rate can be defined as the number of bit intervals per second. And bit interval is referred to as the time needed to transfer one single bit. In simpler words, the bit rate is the number of bits sent in one second, usually expressed in bits per second (bps). For example, kilobits per second (Kbps), Megabits per second (Mbps), Gigabits per second (Gbps), etc.



Definition of Baud Rate

Baud rate is defined as the number of signal units per second. It is always less than or equal to bit rate. It is represented as bauds or symbols/second.

Baud rate is expressed in the number of times a signal can change on transmission line per second. Usually, the transmission line uses only two signal states, and make the baud rate equal to the number of bits per second that can be transferred.



An example can illustrate it. For example, 1500 baud rate illustrates that the channel state can alter up to 1500 times per second. The meaning of changing state means that channel can change its state from 0 to 1 or from 1 to 0 up to 1500 times per second (in the given case).

- bit: a unit of information
- baud: a unit of signaling speed.
- Bit rate:N
  - Number of bits transmitted per second.
- Baud Rate:S
  - Number of symbols transmitted per second.
- General formula:
  - **N=S*r**
  - Where r is number of bits per symbol.

Key Differences Between Bit Rate and Baud Rate

1. Bit rate is the number bits (0's and 1's) transmitted per second.
   On the other hand Baud rate is the number of times a signal is traveling comprised of bits.

2. Baud rate can determine the **bandwidth** of the channel or its required amount to send the signal while through Bit rate it is not possible. Bit Rate can be expressed by the given equation:
   Bit rate = baud rate x the number of bits per signal unit
   In contrary Baud rate is expressed in the given equation:
   Baud rate = bit rate / the number of bits per signal unit

Question: Calculate the baud rate for the given bit rate and type of modulation:
(i) 5000 bps, ASK (ii) 4000 bps, FSK
Answer:

For baud rate (S), we know that the formula is:
S=N/r.
N = S * r
Here, **N** is Bit rate, S is the Baud rate
r = number of bits in signal elements
So, at first we need to calculate r for each case.
We know, $r = \log_2 L$.

i) For ASK, $r = \log_2 2 = 1$
S=5000 bps/1=5000 baud
ii) For FSK, $r = \log_2 2 = 1$
S=4000bps/1=4000 baud

Question: A signal carries five bits in each signal element. If 1600 signal elements are sent per second, find the baud rate and bit rate in kbps.
Answer:

Baud rate(S) is number of signal elements per second.
Bit rate (N) is the number of bits per second.
We also know that **S**=N/r where S is the baud rate, N is the bit rate and r is the bits in each signal element.
In this case 1600 signal elements are sent per second.
So baud rate is 1600.
Now S=1600,r=5 and N is unknown.
So N=S*r=1600*5=8000 bps or 8 kbps.
Therefore the bit rate is 8kbps

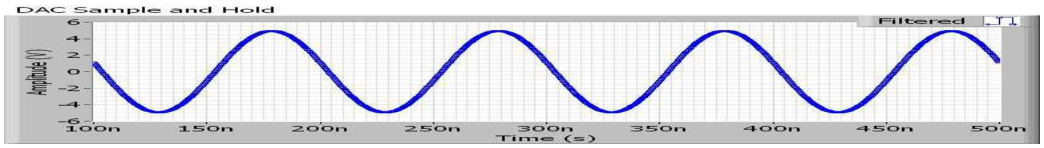
BASIS FOR COMPARISON	BIT RATE	BAUD RATE
Basic	Bit rate is the count of bits per second.	Baud rate is the count of signal units per second.
Meaning	It determines the number of bits traveled per second.	It determines how many times the state of a signal is changing.
Term usually used	the emphasis is on computer efficiency.	data transmission over the channel is more concerned.
Bandwidth determination	Can not determine the bandwidth.	It can determine how much bandwidth is required to send the signal.
Equation	Bit rate = baud rate x the count of bits per signal unit	Baud rate = bit rate / the number of bits per signal unit

Analog Signal and Digital Signal

Analog Signal

An **analog signal** is a continuous wave denoted by a sine wave (pictured below) and may vary in signal strength (amplitude) or frequency (waves per unit time). The sine wave's amplitude value can be seen as the higher and lower points of the wave, while the frequency value is measured in the sine wave's physical length from left to right.

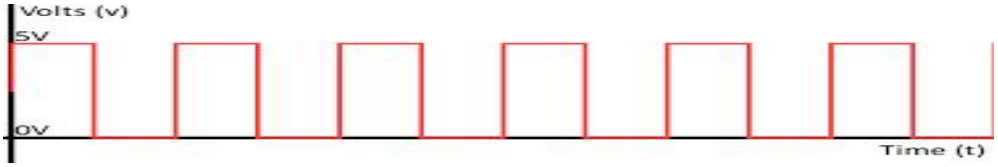
There are many examples of analog signals around us. The sound from a human voice is analog, because sound waves are continuous, as is our own vision, because we see various shapes and colors in a continuous manner due to light waves. Even a typical kitchen clock having its hands moving continuously can be represented as an analog signal.



Digital Signal

A **digital signal** - a must for computer processing - is described as using binary (0s and 1s), and therefore, cannot take on any fractional values. As illustrated in the graphic below, digital

signals retain a uniform structure, providing a constant and consistent signal. Because of the inherent reliability of the digital signal, technology using it is rapidly replacing a large percentage of analog applications and devices. For example, the wristwatch, showing the time of day, with its minute, hour, and sweeping second hands, is being replaced by the digital watch, which offers the time of day and other information using a numerical display. A typical digital signal is represented below. Note the equally dispersed 1s and 0s.



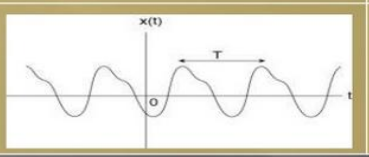
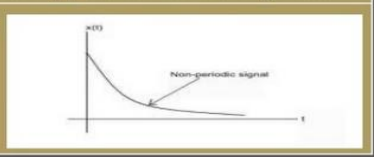
Analog Signal	Digital Signal
An analog signal signifies a continuous signal that keeps changes with a time period.	A digital signal signifies a discrete signal that carries binary data and has discrete values.
Analog signals are continuous sine waves	Digital signal is square waves.
Analog signals describe the behavior of the wave with respect to amplitude, time period, & phase of the signal.	Digital signals describe the behavior of the signal with respect to the rate of a bit as well as bit interval.
Analog signal range will not be set.	Digital signal is limited as well as ranges from 0 to 1.
Analog signal is further horizontal toward distortion during the response to noise	A digital signal has resistance in response toward the noise, therefore, it does not often face distortion.
An analog signal broadcasts the information in the signal form.	A digital signal broadcasts the information in the form of binary that is bits.
The example of an analog signal is the human voice	The example of a digital signal is the data transmission in a computer.

Periodic and Non-periodic signals

- A signal is periodic signal if it completes a pattern within measurable time frame.
- A periodic signal is characterised by **amplitude, frequency and phase.**
- Mathematically: $v(t)=V \sin(2\pi ft+\theta)$
  - V:Peak Amplitude
  - F:frequency
  - t:Time(seconds)
  - θ:Phase(degree or radians)
- **Amplitude** is the highest height of the signal, maximum value or strength of the signal over time; typically, this value is measured in volts.
- **frequency** is the rate [in cycles per second, or Hertz (Hz)] at which the signal repeats., and
- **Phase** is a measure of the relative position in time within a single period of a signal
- An analog signal is not resistant toward the noise, therefore; it faces distortion as well as reduces the transmission quality.

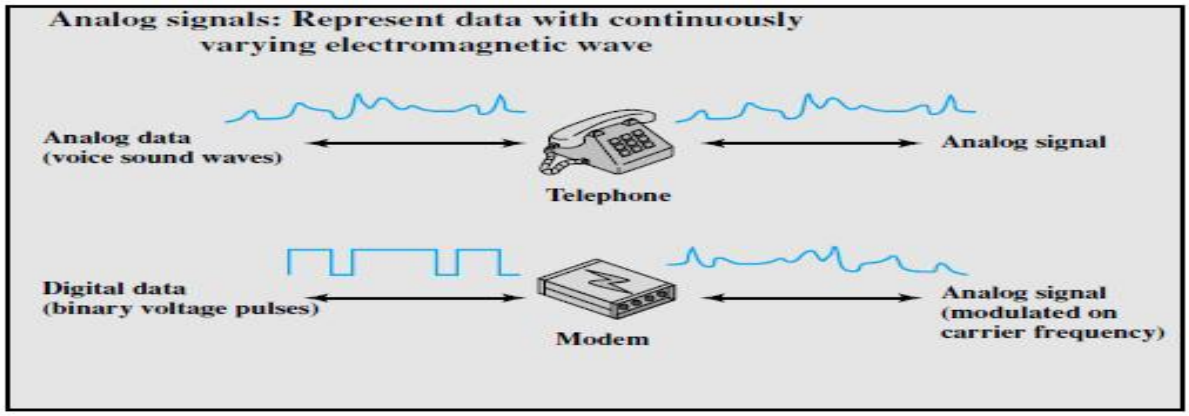
Non-periodic signals

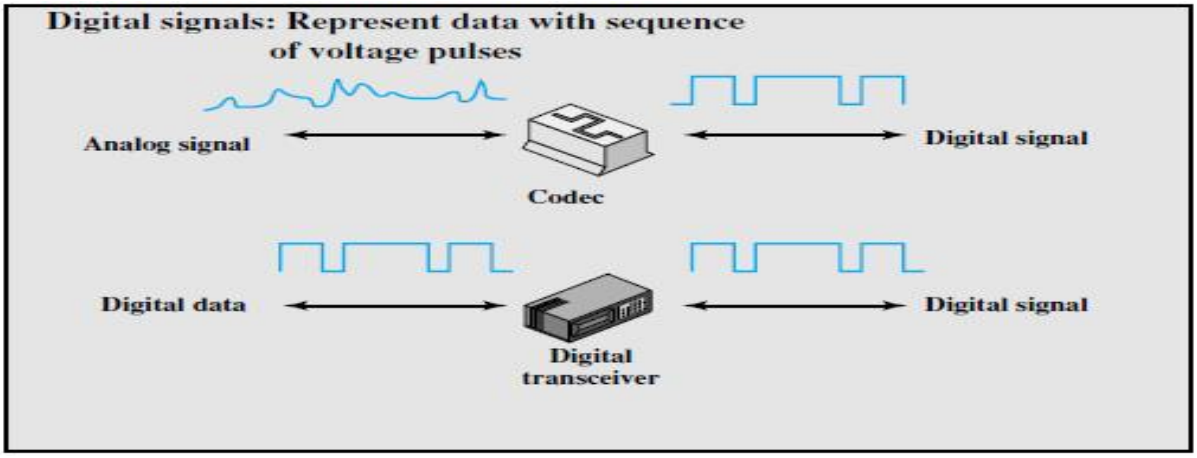
- A signal that does not repeats its pattern over a period is called aperiodic signal or non periodic.
- Both the Analog and Digital can be periodic or aperiodic: but in data communication **periodic analog signals and aperiodic digital** signals are used.

Periodic Signal	Aperiodic Signal
❑ A signal which repeats itself after a specific interval of time is called periodic signal.	❑ A signal which does not repeat itself after a specific interval of time is called aperiodic signal.
❑ A signal that repeats its pattern over a period is called periodic signal	❑ A signal that does not repeats its pattern over a period is called aperiodic signal or non periodic.
❑ They can be represented by a mathematical equation	❑ They cannot be represented by any mathematical equation
❑ Their value can be determined at any point of time	❑ Their value cannot be determined with certainty at any given point of time
❑ They are deterministic signals	❑ They are random signals
❑ Example: sine cosine square sawtooth etc	❑ Example: sound signals from radio , all types of noise signals
❑ Figure: 	❑ Figure: 

Analog and Digital data

- Analog data take on continuous values in time interval.
- For example, voice and video are continuously varying patterns of intensity. Most data collected by sensors, such as temperature and pressure, are continuous valued.
- The most familiar example of analog data is **audio**, which, in the form of acoustic sound waves, can be perceived directly by human beings.
- Digital data take on discrete values; examples are **text and integers**.
- They cannot be easily stored or transmitted by data processing and communications systems in character form.
- Morse code, **International Reference Alphabet (IRA)** are used to translate text into binary.





Analog transmission

- **Analog transmission** is a means of transmitting analog signals without regard to their content; the signals may represent analog data (e.g., voice) or digital data.
- In either case, the analog signal will become weaker (attenuate) after a certain distance.
- To achieve longer distances, the analog transmission system includes amplifiers that boost the energy in the signal.
- Unfortunately, the amplifier also boosts the noise components.

Digital transmission

- **Digital transmission**, in contrast, assumes a binary content to the signal.
- A digital signal can be transmitted only a limited distance before attenuation.
- To achieve greater distances, repeaters are used. A repeater receives the digital signal, recovers the pattern of 1s and 0s, and retransmits a new signal. Thus the attenuation is overcome.

(a) Data and Signals

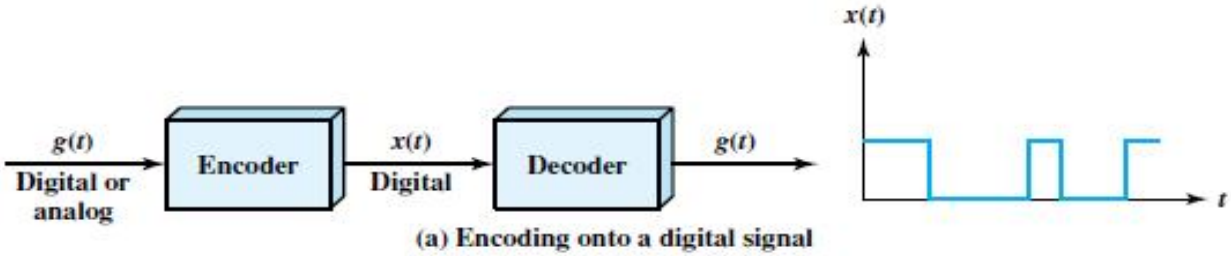
	Analog Signal	Digital Signal
Analog Data	Two alternatives: (1) signal occupies the same spectrum as the analog data; (2) analog data are encoded to occupy a different portion of spectrum.	Analog data are encoded using a codec to produce a digital bit stream.
Digital Data	Digital data are encoded using a modem to produce analog signal.	Two alternatives: (1) signal consists of two voltage levels to represent the two binary values; (2) digital data are encoded to produce a digital signal with desir ed properties.

Both analog and digital information can be encoded as either analog or digital signals. The particular encoding that is chosen depends on the specific requirements to be met and **the media and communications facilities** available.

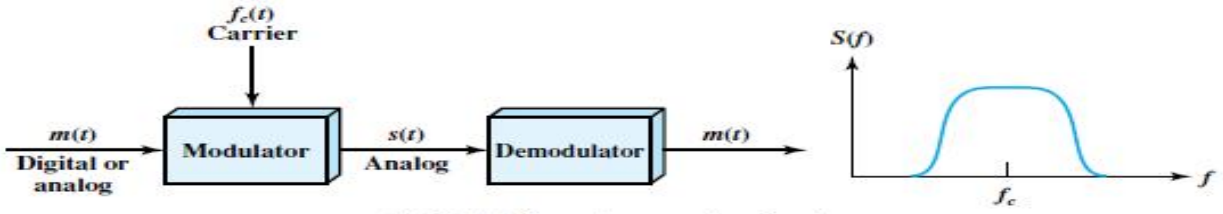
1. **Digital data, digital signals(Digital data Transmission):**
    - The simplest form of digital encoding of digital data is to assign one voltage level to binary one and another to binary zero.
    - More complex encoding schemes are used to improve performance, by altering the spectrum of the signal.
2. **Digital data, analog signal:**
    - A modem converts digital data to an analog signal so that it can be transmitted over an analog line.

- The basic techniques are **amplitude shift keying (ASK), frequency shift keying (FSK), and phase shift keying (PSK)**.
- All involve altering one or more characteristics of a carrier frequency to represent binary data.

3. **Analog data, digital signals:**
   - Analog data, such as voice and video, are often digitized to be able to use digital transmission facilities.
   - The simplest technique is **pulse code modulation (PCM)**, which involves sampling the analog data.
4. **Analog data, analog signals:**
   - Analog data are modulated by a carrier frequency to produce an analog signal, which can be utilized on an analog transmission system.
   - The basic techniques are **amplitude modulation (AM), frequency modulation(FM), and phase modulation (PM).**



(a) Encoding onto a digital signal



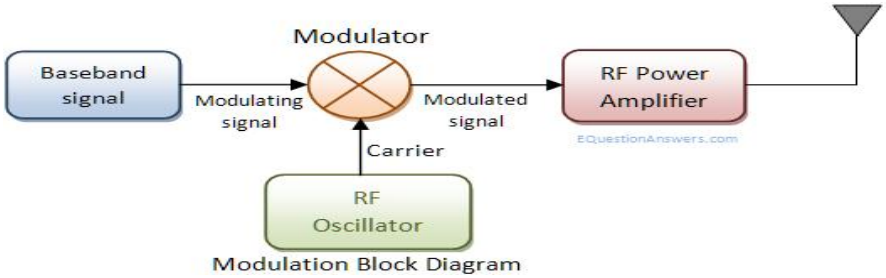
(b) Modulation onto an analog signal

• Modulation:

Now we have to develop some way to send the information of message signal via this carrier signal. The carrier signal is a high frequency sinusoidal signal represented by amplitude, frequency and phase. We can vary one of this parameter accordingly with the message information.

• What is Modulation?

Modulation is an operation of varying amplitude or frequency or phase of carrier signal according to the instantaneous amplitude of the baseband signal/modulating signal.



Modulation Block Diagram

Here baseband signals comes from a audio/video or computer. Baseband signals are also called modulating signal as it modulates carrir signal. Carrier signals are high frequecy radio waves it generally comes from a radio frequency oscillators. These two signls are combined in modulator. Modulator takes the instantenious amplitute of baseband signal and varies amplitute/frequency/phase of carrier signal. Resultant signal is a modulated signal. It goes to an RF-amplifier for signal power boosting and then feed to antenna or a co-axial cable.

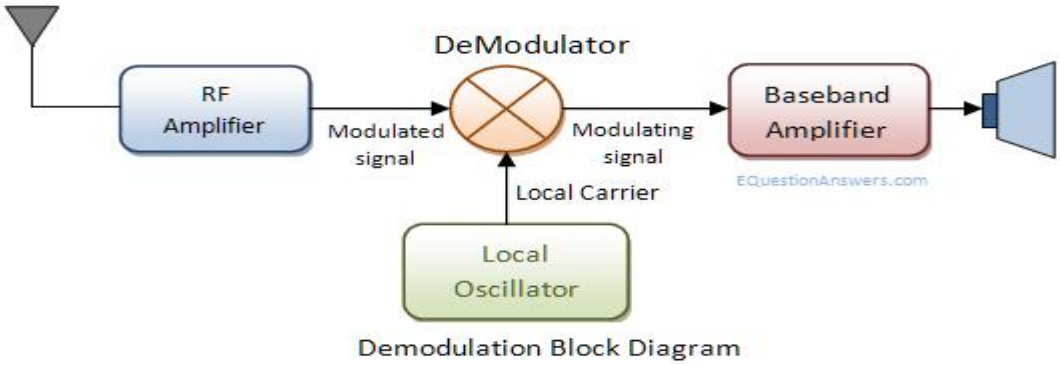
There are two types of modulation analog and digital. Analog modulation delas with the voice, video and regular waves of base band signals. Where as digital modulations are with bit streams or symbols from computing vevices as base band signals.

- ## DeModulation:

Demodulation is the opposite process of modulation. Modulator is a part of signal transmitter where as demodulator is the receiving side. In broadcast system radio transmitting station does to modulation part. A radio receiver acts as a demodulator. A modem receives signals and also transmits signals thus it does modulation and demodulation at the same time. Thus the name modem has been given. A radio antenna receives low power signal. A co-axial cable end point can also take as an signal input. An RF amplifier boosts the signal amplitude. Then the signal goes to a demodulator. demodulator does the reverse of modulation and extracts the backband signal from carrier. Then the base band signal is amplified to feed a audio speaker or video monitor or TTL/CMOS signal levels to match computer inputs.

- ## What is De-modulation?

Demodulation is the opposite process of modulation where the varying amplitude, frequency or phase of carrier signal is extracted to construct the original the message signal.



Demodulation Block Diagram

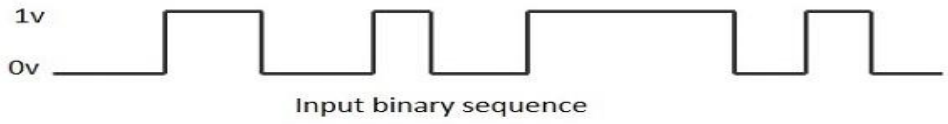
Digital to Analog conversion

- The case of transmitting digital data using analog signals.
- The most familiar use is for transmitting digital data through the public telephone network.
- The telephone network was designed to receive, switch, and transmit analog signals in the voice-frequency range of about 300 to 3400 Hz.
- It is not at present suitable for handling digital signals from the subscriber locations.
- Thus digital devices are attached to the network via a **modem (modulator-demodulator)**, which converts digital data to analog signals, and vice versa.
- Modulation involves operation on one or more of the three characteristics of a carrier signal: **amplitude, frequency, and phase.**
- Accordingly, there are three basic encoding or modulation techniques for transforming digital data into analog signals:
    - Amplitude Shift Keying (ASK),
    - Frequency Shift Keying (FSK), and
    - Phase Shift Keying (PSK).

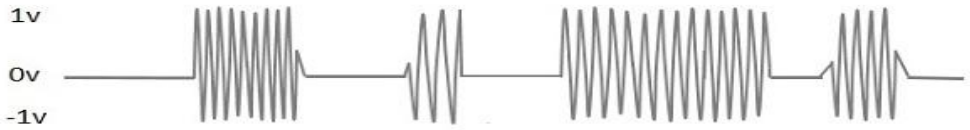
1. Amplitude Shift Keying (ASK)

- ASK is the digital carrier Modulation in which amplitude of carrier will take one of the two values in response to 0 or 1 value of digital data.

- **Amplitude Shift Keying (ASK)** is a type of Amplitude Modulation which represents the binary data in the form of variations in the amplitude of a signal.
- Any modulated signal has a high frequency carrier. The binary signal when ASK modulated, gives a **zero** value for **Low** input while it gives the **carrier output** for **High** input.
- The following figure represents ASK modulated waveform along with its input.



Input binary sequence

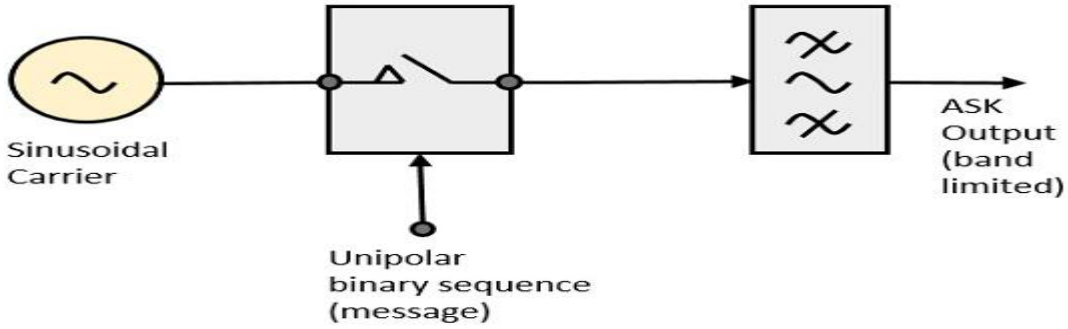


ASK Modulated output wave

ASK Modulator

The ASK modulator block diagram comprises of the carrier signal generator, the binary sequence from the message signal and the band-limited filter. Following is the block diagram of the ASK Modulator.

ASK Generation method

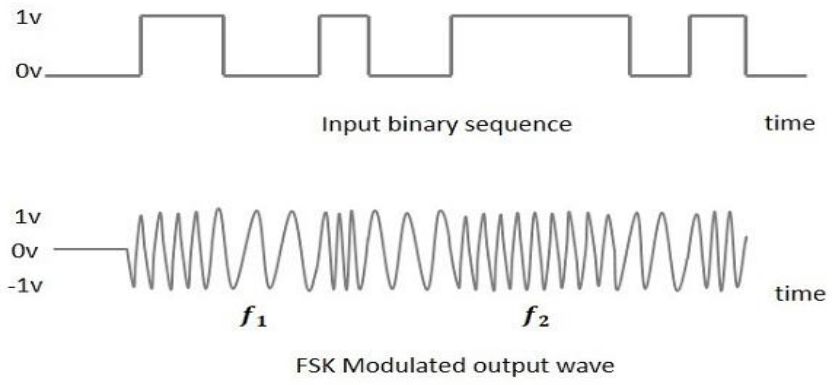


Application:

1. Used in our infrared remote controls
2. Used in fibre optical tranmitter and receiver.

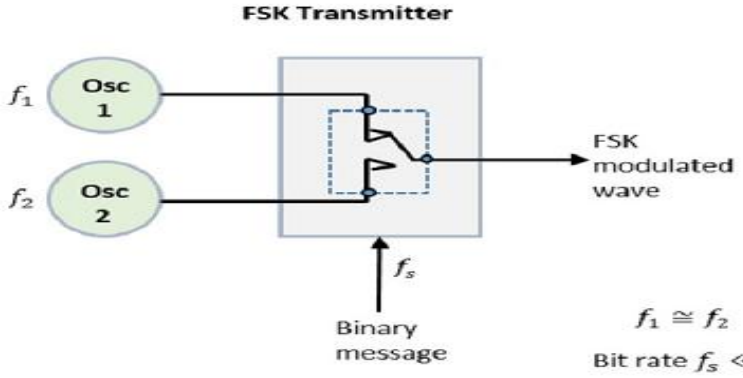
2. Frequency Shift Keying (FSK)

- **Frequency Shift Keying (FSK)** is the digital modulation technique in which the frequency of the carrier signal varies according to the digital signal changes. FSK is a scheme of frequency modulation.
- The output of a FSK modulated wave is high in frequency for a binary High input and is low in frequency for a binary Low input. The binary **1s** and **0s** are called Mark and Space frequencies.
- The following image is the diagrammatic representation of FSK modulated waveform along with its input.



FSK Modulator

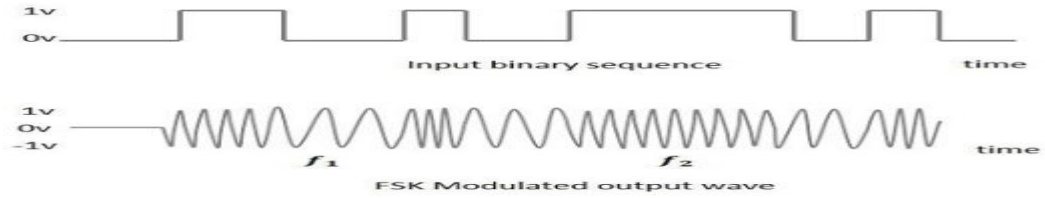
The FSK modulator block diagram comprises of two oscillators with a clock and the input binary sequence. Following is its block diagram.



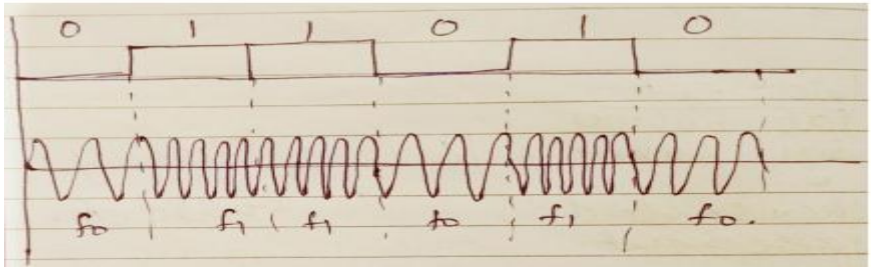
The two oscillators, producing a higher and a lower frequency signals, are connected to a switch along with an internal clock. To avoid the abrupt phase discontinuities of the output waveform during the transmission of the message, a clock is applied to both the oscillators, internally. The binary input sequence is applied to the transmitter so as to choose the frequencies according to the binary input.

Question: Explain the process of FSK modulation with diagram. (4Marks)
Answer: In FSK, frequency of sinusoidal carrier is shifted between two discrete values. One of these frequencies (f_1) represents a binary 1 and other value (f_2) represents binary 0.There is no change in amplitude of carrier. It consists of voltage controlled oscillators (VCO) which produce sine waves at frequencies f_1 and f_0. Corresponding to "binary 0 "input, the VCO

produces a sinewave of frequency f_0 whereas corresponding to binary 1 input VCO produces a sinewave of frequency f_1.



Question: Draw a BFSK waveform to represent the following bit stream 0 11 0 1 0.



Application:

1. Many modems used FSK in telemetry systems

3. Phase Shift Keying (PSK)

Phase Shift Keying (PSK) is the digital modulation technique in which the phase of the carrier signal is changed by varying the sine and cosine inputs at a particular time. PSK technique is widely used for wireless LANs, bio-metric, contactless operations, along with RFID and Bluetooth communications.

PSK is of two types, depending upon the phases the signal gets shifted. They are −

Binary Phase Shift Keying (BPSK)

This is also called as 2-phase PSK or Phase Reversal Keying. In this technique, the sine wave carrier takes two phase reversals such as 0° and 180°.

BPSK is basically a Double Side Band Suppressed Carrier (DSBSC) modulation scheme, for message being the digital information.

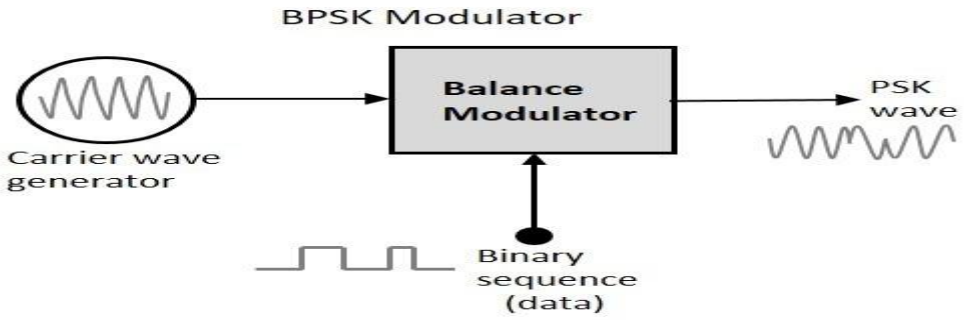
Quadrature Phase Shift Keying (QPSK)

This is the phase shift keying technique, in which the sine wave carrier takes four phase reversals such as 0°, 90°, 180°, and 270°.

If this kind of techniques are further extended, PSK can be done by eight or sixteen values also, depending upon the requirement.

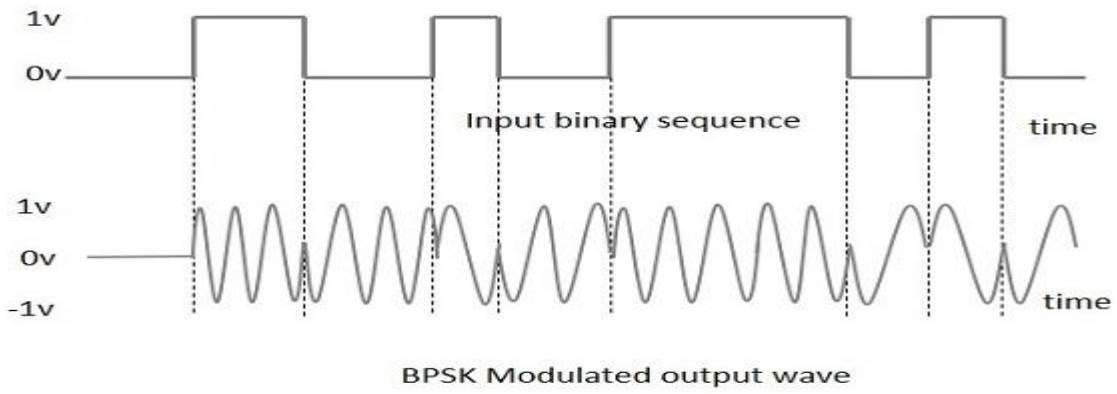
BPSK Modulator

The block diagram of Binary Phase Shift Keying consists of the balance modulator which has the carrier sine wave as one input and the binary sequence as the other input. Following is the diagrammatic representation.



The modulation of BPSK is done using a balance modulator, which multiplies the two signals applied at the input. For a zero binary input, the phase will be **0°** and for a high input, the phase reversal is of **180°**.

Following is the diagrammatic representation of BPSK Modulated output wave along with its given input.

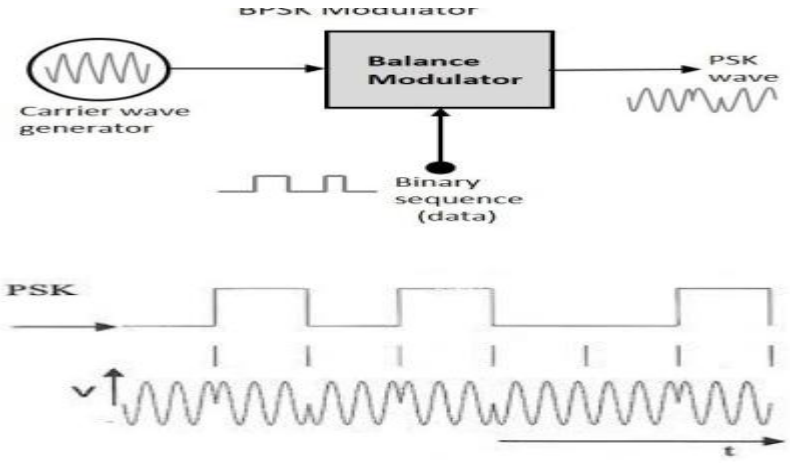


BPSK Modulated output wave

The output sine wave of the modulator will be the direct input carrier or the inverted (180° phase shifted) input carrier, which is a function of the data signal.

Question: Explain process of phase shift keying.(4 Marks)

Answer: Phase-shift keying (PSK) is a digital to analog modulation scheme based on changing, or modulating, the initial phase of a carrier signal. PSK is used to represent digital information, such as binary digits zero (0) and one (1).The modulation of PSK is done using a balance modulator, which multiplies the two signals applied at the input. For a zero binary input, the phase will be 180° and for a high input, the phase reversal is of 0°. Following is the diagrammatic representation of PSK Modulated output wave along with its given input.



The output sine wave of the modulator will be the direct input carrier or the inverted (180° phase shifted) input carrier, which is a function of the data signal. Amplitude and frequency of the original carrier signal is kept constant.

Application:

1. Used in our ADSL broadband modem
2. Used in satellite communication
3. Used in our mobile phones

Comparison of ASK, FSK and PSK

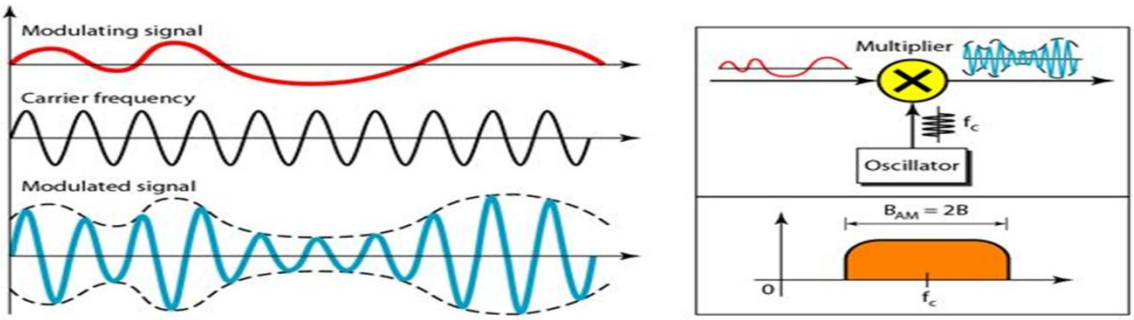
Parameters	ASK	FSK	PSK
Variable characteristics	Amplitude	Frequency	Phase
Bandwidth	Is proportional to signal rate (B =(1+d)S),d is due to modulation & filtering ,lies between 0 & 1.	B=(1+d)×S+2Δf	B=(1+d)×S
Noise immunity	low	High	High
Complexity	Simple	Moderately complex	Very complex
Error probability	High	Low	Low
Performance in presence of noise	Poor	Better than ASK	Better than FSK
Bit rate	Suitable upto 100 bits/sec	Suitable upto about 1200 bits/sec	Suitable for high bit rates

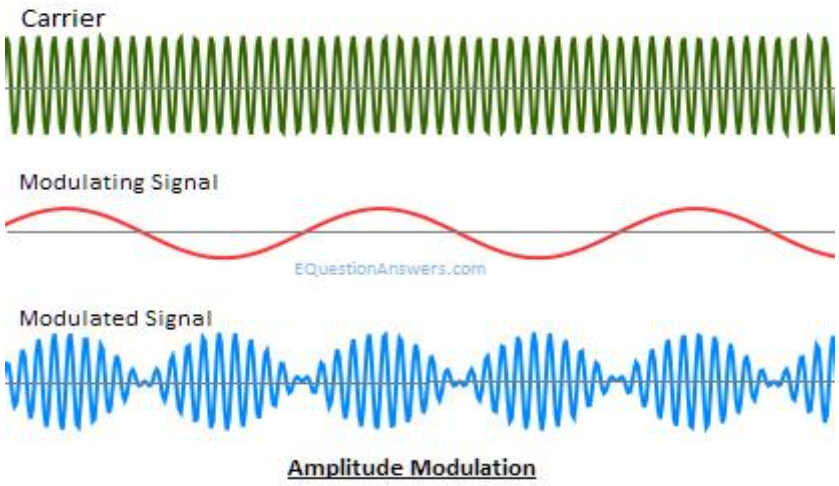
- ## Analog to Analog Conversion

  - Analog-to-analog conversion, or modulation, is the representation of analog information by an analog signal.
  - It is a process by which a characteristic of carrier wave is varied according to the instantaneous amplitude of the modulating signal.
  - Analog to Analog conversion can be done in three ways:
    - **Amplitude Modulation**
    - **Frequency Modulation**
    - **Phase Modulation**

1. AMPLITUDE MODULATION:

- The modulation in which the **amplitude** of the carrier wave is varied according to the instantaneous amplitude of the modulating signal keeping **phase and frequency** as constant.
- AM is normally implemented by using a simple multiplier because the amplitude of the carrier signal needs to be changed according to the amplitude of the modulating signal.
- **AM bandwidth:**
  The modulation creates a bandwidth that is twice the bandwidth of the modulating signal and covers a range centered on the carrier frequency.
  Bandwidth= 2fm





Amplitude Modulation

- ## AM Advantage

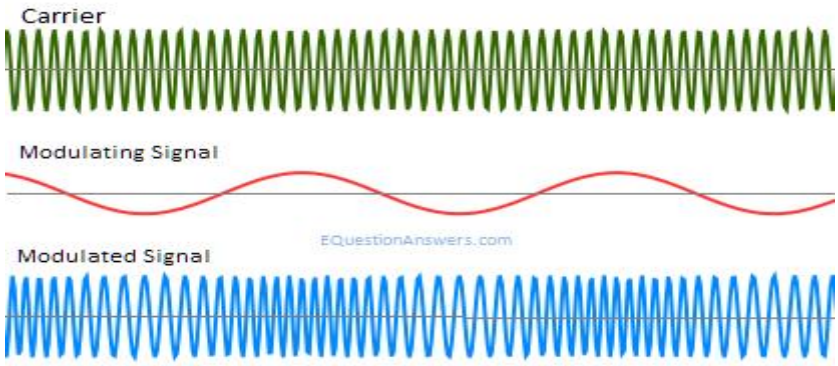
  - AM is the simplest type of modulation. Hardware design of both transmitter and receiver is very simple and less cost effective.

- ## AM Disadvange:
  - AM is very susceptible to noise.

- **Application:**
  - AM radio broad cast is an example

2. Frequency modulation

FM or Frequency modulation is the process of varying the in instantaneous frequency of Carrier signal accordingly with instantaneous amplitude of message signal.



Frequency Modulation

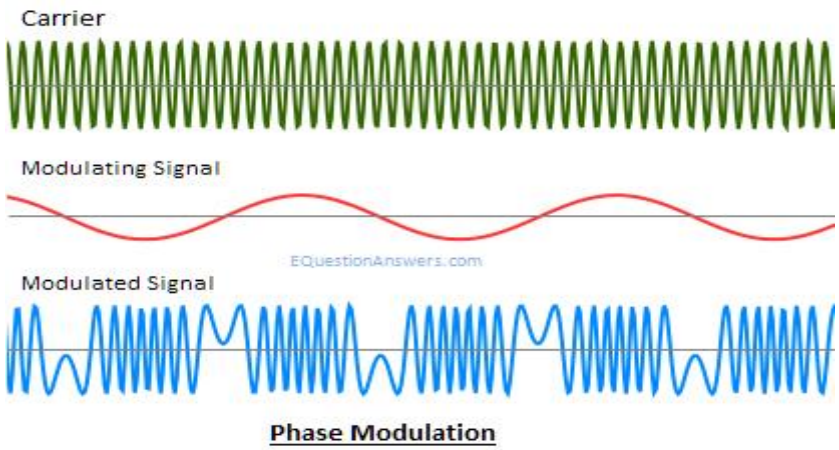
- **FM Advantage**
  - Modulation and demodulation does not catch any channel noise.
- **FM Disadvange:**
  - Circuit needed for FM modulation and demodulation is bit complicated than AM
- **Application:**
  - FM radio broad cast is an example

Question: Compare amplitude modulation and frequency modulation (4 points).
Answer:

Parameter	Amplitude modulation (AM)	Frequency modulation (FM)
Definition	Amplitude modulation (AM) is the process of changing the amplitude of a high frequency carrier signal in proportion with the instantaneous value of the modulating signal keeping frequency &Phase constant.	Frequency modulation (FM) is the process of changing the frequency of carrier signal in proportion with the instantaneous value of the modulating signal keeping Amplitude &Phase constant.
Waveform	AM wave: 	FM wave: 
Bandwidth	BW= $2f_m$(f_m -frequency of modulating signal)	Bandwidth =2 [$\delta + f_m$] (f_m - frequency of modulating signal)
Noise immunity	Less	More
Modulation index	$m_a = \frac{V_m}{V_c}$ V_m - Amplitude of modulating signal V_c- Amplitude of carrier signal	$m_f = \frac{\delta}{f_m}$ δ – frequency deviation f_m - frequency of modulating signal
Frequencies used for transmission	535 – 1700 KHz	88.1 – 108.1 MHz

3. Phase modulation (PM)

PM or Phase modulation is the process of varying the instantaneous phase of Carrier signal accordingly with instantaneous amplitude of message signal.



Phase Modulation

- **PM Advantage**
  - Modulation and demodulation does not catch any channel noise.
- **PM Disadvange:**
  - Circuit needed for PM modulation and demodulation is bit complicated than AM and FM
- **Application:**
  - Satellite communication.

Fundamentals of Computer Network

Definition and Need of Computer Network

A computer network is a group of computer systems and other computing hardware devices that are linked together through communication channels to facilitate communication and resource-sharing among a wide range of users.

OR

Two or more computers that are linked in order to share resources (such as printers and CDs), exchange files, or allow electronic communications.

The computers on a network may be linked through cables, telephone lines, radio waves, satellites, or infrared light beams.

The Concept of Networking

The idea of networking has been around for a long time and has taken on many meanings. If you were to look up "network" in your dictionary, you might find any of the following definitions:

- An openwork fabric; netting
- A system of interlacing lines, tracks, or channels
- Any interconnected system; for example, a television-broadcasting network

- A system in which a number of independent computers are linked together to share data and peripherals, such as hard disks and printers

Obviously, the last definition is the one we are concerned with in this course. The key word in the definition is "share." Sharing is the purpose of computer networking. The ability to share information efficiently is what gives computer networking its power and its appeal. And when it comes to sharing information, human beings are in many ways similar to computers. Just as computers are little more than collections of the information they have been given, so we are, in large part, collections of our experiences and the information given to us. When we want to expand our knowledge, we broaden our experience and gather more information. For example, to learn more about computers, we might talk informally with friends in the computer industry, go back to school and take a class, or work through a self-paced training course like this one. Whichever options we choose, when we seek to share the knowledge and experiences of others, we are networking.

Another way to think of networking is to envision a network as a team. This might be a sports team, such as a football team, or a project team, such as the one that created this training course. Through the efforts of all involved—the sharing of time, talent, and resources—a goal is accomplished or a project is completed. Similarly, managing a computer network is not unlike managing a team of people. Sharing and communicating can be simple and easy (a quarterback calling a play in the huddle) or complex (a virtual project team located in different time zones around the world that communicates through teleconferencing, e-mail, and multimedia presentations over the Internet to complete a project).

Introducing Computer Networking

At its most elementary level, a computer network consists of two computers connected to each other by a cable that allows them to share data. All computer networking, no matter how sophisticated, stems from that simple system. While the idea of connecting two computers by a cable may not seem extraordinary, in retrospect it has proven to be a major achievement in communications.

Computer networking arose as an answer to the need to share data in a timely fashion. Personal computers are powerful tools that can process and manipulate large amounts of data quickly, but they do not allow users to share that data efficiently. Before networks, users needed either to print out documents or copy document files to a disk for others to edit or use them. If others made changes to the document, there was no easy way to merge the changes. This was, and still is, known as "working in a stand-alone environment." (See Figure 1.1.)

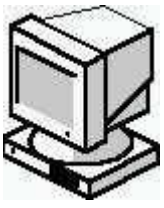


Figure 1.1 Stand-alone environment

Copying files onto floppy disks and giving them to others to copy onto their computers was sometimes referred to as the "sneakernet." This early form of computer networking is one that many of us have used and perhaps still use today. See Figure 1.2; it might bring back some fond memories.

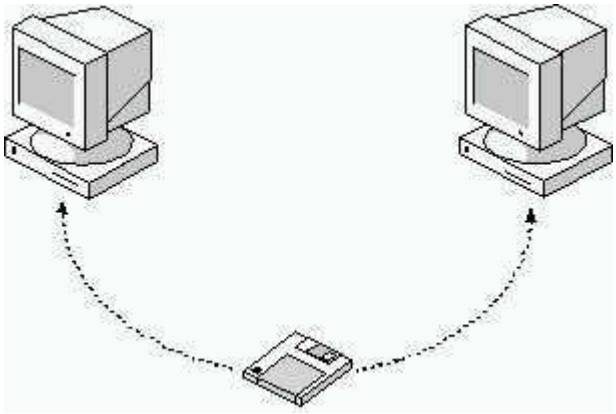


Figure 1.2 The sneakernet

This system works well in certain situations and has its advantages—it allows us to stop for a cup of coffee or socialize with a friend while we exchange and merge data—but it is far too slow and inefficient to meet the needs and expectations of today's computer users. The amount of data available to be shared and the distances we want the data to travel far exceed the capabilities of the sneakernet.

But what if the computer shown in Figure 1.1 were to be connected to other computers? Then, it could share data with the other computers and send documents to the other printers. This connecting together of computers and other devices is called a network, and the concept of connected computers sharing resources is called networking. (See Figure 1.3.)

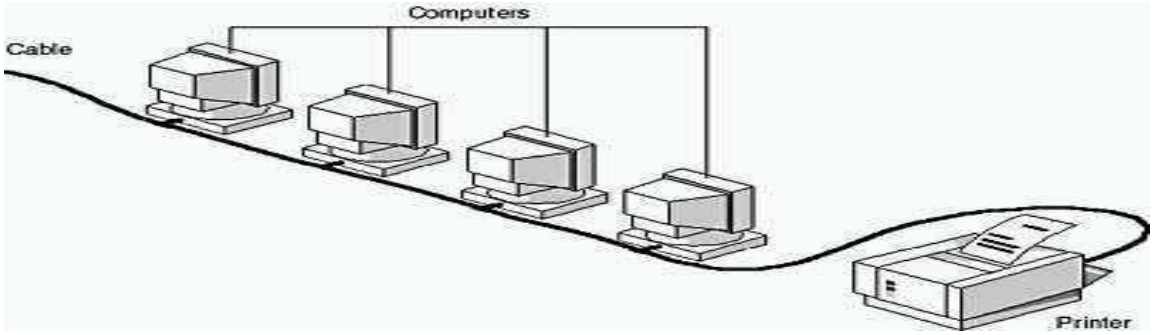


Figure 1.3 A simple computer network

Why Use a Computer Network? (Need)

With the availability and power of today's personal computers, you might ask why networks are needed. From the earliest networks to today's high-powered personal computers, the answer has remained the same: networks increase efficiency and reduce costs. Computer networks achieve these goals in three primary ways:

- Sharing information (or data)
- Sharing hardware and software
- Centralizing administration and support

More specifically, computers that are part of a network can share:

- Documents (memos, spreadsheets, invoices, and so on).
- E-mail messages.
- Word-processing software.

- Project-tracking software.
- Illustrations, photographs, videos, and audio files.
- Live audio and video broadcasts.
- Printers.
- Fax machines.
- Modems.
- CD-ROM drives and other removable drives, such as Zip and Jaz drives.
- Hard drives.

And more sharing options exist. The capabilities of networks are constantly expanding as new ways are found to share and communicate by means of computers.

Sharing Information (or Data)

The ability to share information quickly and inexpensively has proven to be one of the most popular uses of networking technology. It has been reported that e-mail is by far the number-one activity of people who use the Internet. Many businesses have invested in networks specifically to take advantage of network-based e-mail and scheduling programs.

By making information available for sharing, networks can reduce the need for paper communication, increase efficiency, and make nearly any type of data available simultaneously to every user who needs it. Managers can use these utilities to communicate quickly and effectively with large numbers of people and to organize and schedule meetings with people drawn from an entire company or business enterprise far more easily than was previously possible.

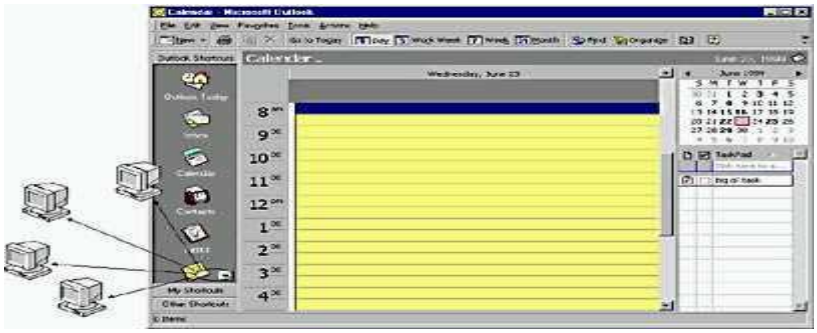


Figure 1.4 Scheduling a meeting with Microsoft Outlook

Sharing Hardware and Software

Before the advent of networks, computer users needed their own printers, plotters, and other peripherals; the only way users could share a printer was to take turns sitting at the computer connected to the printer. Figure 1.5 shows a typical stand-alone workstation with a printer.

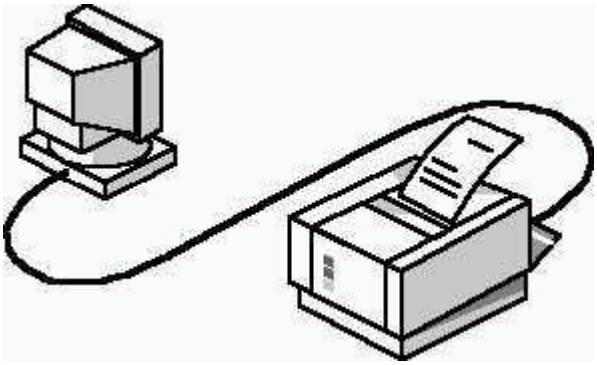


Figure 1.5 A printer in a stand-alone environment

Networks make it possible for several people to share data and peripherals simultaneously. If many people need to use a printer, they can all use the printer available on the network. Figure 1.6 shows a typical network environment in which five workstations share a single printer.

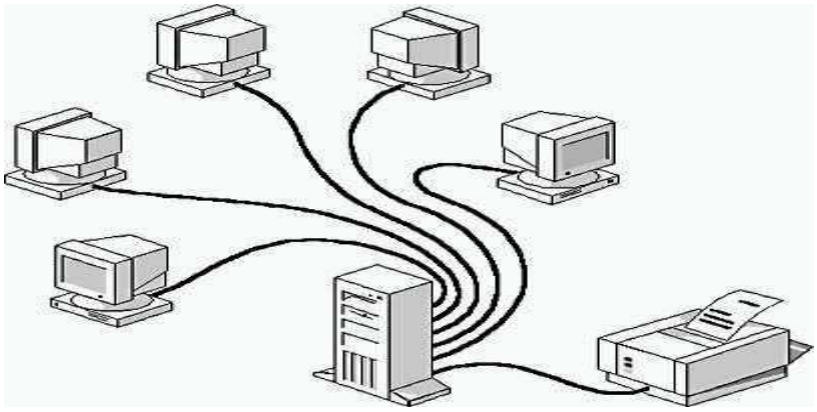


Figure 1.6 Sharing a printer in a networking environment

Networks can be used to share and standardize applications, such as word processors, spreadsheets, inventory databases, and so on, to ensure that everyone on the network is using the same applications and the same versions of those applications. This allows documents to be shared easily and creates training efficiencies: it is easier for people to master one word processing application thoroughly than to try to learn four or five different word processing applications.

Centralizing Administration and Support

Networking computers can simplify support tasks as well. It is far more efficient for technical personnel to support one version of one operating system or application and to set up all computers in the same manner than to support many individual and unique systems and setups.

Give advantages and disadvantages of computer network.

Advantages:

1. **File sharing:** The major advantage of computer network is that it allows file sharing and remote file access. A person sitting at one workstation that is connected to a network can easily see files present on another workstation, provided he/she is authorized to do so.

2. **Resource Sharing**: A computer network provides a cheaper alternative by the provision of resource sharing. All the computers can be interconnected using a network and just one modem & printer can efficiently provide the services to all users.

3. **Inexpensive set-up:** Shared resources means reduction in hardware costs. Shared files means reduction in memory requirement, which indirectly means reduction in file storage expenses.

4**. Flexible Handling:** A user can log on to a computer anywhere on the network and access his/her files. This offers flexibility to the user as to where he/she should be during the course of his/her routine.

Disadvantages:

1. **Security concerns:**
   One of the major drawback of computer network is the security issues that are involved.
2. **Virus and malware**:
   Viruses can spread on a network easily because of the interconnectivity of workstations.
3. **Lack of robustness:**
   If the main file server of a computer network breaks down, the entire system becomes useless.
4. **Needs an efficient handler:**
   The technical skills and knowledge required to operate and administer a computer network.

Enlist essential components required to design computer network. Describe any one in brief.

The components of computer network are: Hub,Router ,Modem ,Bridge ,Switches, Network Interface Card, Cables and connectors, crimping tool ,LAN tester ,Computers Gateways
Explanation:

1) **HUB**: Hub is a connecting device; it is also known as multiport repeater. It is normally used for connecting stations in a physical star topology All networks require a central location to bring media segments together. These central locations are called hubs. A hub organizes the cables and relays signals to the other media segments. There are three main types of hubs: 1) **Passive** 2) **Active** 3) **Intelligent Passive Hubs**: A passive hubs simply combines the signals of a network segments. There is no signal processing or regeneration. A passive hub reduces the cabling distance by half because it does not boost the signals and in fact absorbs some of the signal. With the passive hub each computer receives the signal sent from all the other computers connected to the hub. Active hubs: They are like passive hubs but have electronic components for regeneration and amplification of signals. by using active hubs the distance between devices can be increased. The main drawback of active hubs is that the amplify noise along with the signals. They are also much expensive than passive hubs. Intelligent hubs: in addition to signal regeneration, intelligent hubs perform some network management and intelligent path selection. One advantage to this is that all transmission media segment can be connected permanently because each segment will be used only when a signal is sent to a device using that segment.

2) **ROUTER**: Router is a device that connects 2 or more networks. It consist of hardware and software .hardware includes the physical interfaces to the various

networks in the internetwork. Software in a router is OS and routing protocols management software. 1) Router use logical and physical addressing to connect two or more logically separate networks. 2) They accomplish this connection by organizing the large network into logical network called subnets. 3) Each of the subnet is given a logical address. This allows the network to be separate but still access to each other and exchange data. 4) Data is grouped into packets. Each packet has physical device address and logical network address.

3) **MODEM:** Modem works as modulator as well as demodulator. Modem converts analog signal to digital signal and vice versa. In case of networking data has to be transferred from one location to another location. At present to transfer such data whatever the infrastructure (PSTN) is available .it is of analog technology but computer sends digital data to transfer this data to another location it is needed to convert into analog format so that it can be transferred by using currently available infrastructure.

4) **Switch:** A switch is a small hardware device that joins multiple computers together within one Local Area Network (LAN). Network switches operate at Data Link Layer of the OSI model. A switch is device that provides a central connection point for cables from workstations, servers and peripherals.

5) **Bridge:** It is a device which connects two or more segment of a network. Use in DLL. If only forwards the packet which are for other.

6) **Gateway:** It is a device which connects two different dissimilar networks which has similar function of communication. It is also called as protocol convertor. It works in all layers of OSI model.

Discuss any four network features.

(1 mark for each feature, any four features)

Discuss any four network features.

1) **File sharing:** File sharing is the primary feature of network. Due to use of networks, the sharing of files becomes easier. File sharing requires a shared directory or disk drive to which many users can access over the network. When many users are accessing the same file on the network, more than one person can make changes to a file at the same time. They might both making conflicting changes simultaneously.

2) **Printer sharing:** Printer sharing is beneficial to many users as they can share costly & higher quality printers. Printer sharing can be done in several different ways on network. The most common way is to use printer queues on server. The printer queue holds print job until any currently running print jobs are finished & then automatically send the waiting jobs to the printer i.e. printer connected to server. Another way to share printer on a network is that each workstations accesses the printer directly.

3) **Application services:** You can also share application on a network. For example you can have a shared copy of Microsoft office or some other application & keep it on the network server. Another application services you can have on the network is shared installation i.e. contents of CD-ROM copy to the server, then run the installation the installing application mush faster & more convenient.

4) **E- mail services**: E-mail is extremely valuable & important feature for communication within organization or outside the people in world. E-mail service can be used by user in two different ways : 1. File based 2.Client

File based e-mail system requires gateway server for connecting or handling the e-mail interface between the two systems using gateway software that is part of the file-based e-mail system.

A client-server e-mail system is one where an e-mail server containing the messages & handles all incoming & outgoing mail. It is more secure & powerful than file based e-mail system.

5) **Remote access:** Using this feature user can access their file & e-mail, when they are travelling or working on remote location. It enables users to access to centralized application, stored private or shared files on LAN.

6) **Internet & Intranet**: Internet: It is public network. This consists of thousands of individual networks & millions of computers located around the world. Internets have many different types of services available such as e-mail, the web & Usenet newsgroups.

Intranet: It is private network or it is company's own network. Company use this feature for internal use. For example: company establish its own web server, for placing documents such as employee handbooks, purchases form or other information that company publishes for internal use. It also has internet services such as FTP servers or Usenet servers.

7) **Network security**: Internal & External

Enlist eight applications of computer network.

Applications of Compute Network

1) Banking 2) Video conferencing 3) Marketing 4) School 5) Radio 6) Television 7) E-mail

8) Companies
OR

1. Sharing the resources such as printers among all the users.

2. Sharing of expensive software & hardware.

3. Communication from one computer to other.

4. Exchange of data & information amongst the users, via the network.

5. Sharing of information over the geographically wide areas.

6. For connecting the computers between various buildings of an organisation.

7. For educational purposes.

8. Maintenance is limited to the servers & clients.

Types of Computer Network

Networks are classified depending on the geography & their components role and Trasmission Technology

1. Classification of network by their geography:

- LAN - Local Area Network
- MAN - Metropolitan Area Network
- WAN - Wide Area Network
- CAN - Campus Area Network
- PAN - Personal Area Network

2. Classification by their components by their component role:

    1. Peer-to- Peer Network
    2. Client-server network

3. Classification based on Transmission Technology

    1. Broadcast Network
    2. Point to Point Network

1. Classification of network by their geography:

PAN:

A PAN is personal area network is used for communication among computer devices close to one's person. Wireless networking or Bluetooth technologies are the some examples of PAN. The communication network established for the purpose of connecting computer devices of personal use is known as the PAN.

CAN:

CAN is a Campus Area Network is used to connect buildings across campuses of colleges or Universities. A CAN is actually a type of LAN. It is larger than a LAN but smaller than MAN.

CAN is a network that connects two or more LANs but that is limited to a specific and contiguous geographical area such as a college campus, industrial complex or military base.

Advantages:

1. CAN is economical.
2. CAN is simple and easy to implement.
3. Helpful for universities & corporate organization to work from any block and receive the same speed of data together.

LAN:

- LAN is local area network.
- LAN is privately-owned networks covering a small geographic area(less than 1 km), like a home, office, building or group of buildings.
- LAN transmits data with a speed of several megabits per second.

Advantages:

- The reliability of network is high because the failure of the computer in the network does not affect the functioning for other computers.
- Addition of new computer to network is easy.
- High rate of data transmission is possible.
- Loss expensive to install.

MAN:
A Metropolitan Area Network (MAN) is a large computer network that spans a metropolitan area or campus. A MAN typically covers an area up to 10 kms (city). The best example of MAN is the cable Television network, available in many cities. For an organization, the common use of a MAN is to extend their LAN connectivity between buildings/offices that are within the same city or urban area (hence the name Metropolitan Area Network). The organization can pass their Ethernet frames to the service provider MAN; the service provider will carry their frames across the MAN; and then deliver the frames to the destination site. From the customer's point of view, the MAN looks like one big (long) Ethernet link between their offices. The different sites could belong to the same IP subnet, and from the customer's viewpoint, no routing is required between their sites.
Advantages:
1. MAN spans large geographical area than LAN.
2. MAN falls in between the LAN and WAN therefore, increases the efficiency at handling data.
WAN:
WAN is wide area network. WAN is a long-distance communication network that covers a wide geographic area, such as state or country. The most common example is internet. A WAN provides long-distance transmission of data, voice, image and video information over larger geographical areas that may comprise a country or even whole world.

Advantages:
1. WAN can connect the computer to a wider area geographically.
2. WAN shares software & resources with connecting workstations.

Classification of network by their component role:
1. **Peer-to-Peer Network**:
- Peer networks are defined by lack of central control over network.
- There are no fixed division into client & server. In this individual who forms a loose group can communicate with other in the group as shown in fig.
- Each computer is responsible for accessing & maintaining its own security & resources.
- In Peer-to- Peer network every computer can function both as client & server.
- In this type of network user simply share disk space & resources.

Advantages:
1. No extra investment in server hardware & software is required.
2. Easy set-up.
3. No network administrator required.

Disadvantages:
1. Additional load due to sharing of resources.
2. Lack of central organization, which can make data hard to find.
3. Weak security.

Client -Server network (Server-based network)
Fig. shows server- based network. Server based networks are defined by presence of servers on a network that provides security & administration of network. Server-based network divide processing takes between client & servers. Client request service such as file printing & servers deliver them. Servers are more powerful than client computers.

Advantages:
1. Strong central security
2. Ability to share expensive equipment's such as printer.
3. Ability of server to pull available hardware & software.
4. Easy manageability of large user.

Disadvantages:
1. Expensive dedicated hardware.
2. Expensive network operating system software & client license.
3. A dedicated network administrator.

Difference between LAN,MAN and WAN

Parameter	LAN	MAN	WAN
Full Form	LAN is an acronym for Local Area Network.	MAN is an acronym for Metropolitan Area Network.	WAN is an acronym for Wide Area Network.
Definition and Meaning	LAN is a network that usually connects a small group of computers in a given geographical area.	MAN is a comparatively wider network that covers large regions- like towns, cities, etc.	The WAN network spans to an even larger locality. It has the capacity to connect various countries together. For example, the Internet is a WAN.
Network Ownership	The LAN is private. Hospitals, homes, schools, offices, etc., may own it.	The MAN can be both private or public. Many organizations and telecom operators may own	The WAN can also be both private or public.
Maintenance and Designing	Very easy to design and maintain.	Comparatively difficult to design and maintain.	Very difficult to design and maintain.
Speed	LAN offers a very high Internet speed.	MAN offers a moderate Internet speed.	WAN offers a low Internet speed.
Delay in Propagation	It faces a very short propagation delay.	It faces a moderate propagation delay.	It faces a high propagation delay.
Uses	Schools, homes, colleges, hospitals, offices, etc., can privately use it.	It basically covers a city, a small town, or any given area with a bigger radius than the LAN.	It covers an entire country, a subcontinent, or an equivalent area.

State any four advantages of server based network over peer to peer network. (Each advantage -1 Mark, any four advantages)

Answer:

1. Server based network has Strong central security over peer to peer network.
2. Sever based network has better performance for large number of users than Peer to –Peer network.
3. Centralized backup can be taken in server based network.
4. Easy manageability for large number of users.
5. Very reliable dedicated Network operating system (NOS) required.
6. In server based network server is more powerful than client.