<u>Solutions-CN1-IAT-1</u>

1. Transmission modes.

Simplex Mode:

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.

Half Duplex:

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.

Full-Duplex:

In full-duplex mode, 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, Signal 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.

b) Ring Topology:

In a ring topology, each device has a dedicated point-to-point connection with only the two devices on either side of it. A signal is passed along the ring in one direction, from device to device, until it

reaches its destination. Each device in the ring incorporates a repeater. When a device receives a signal intended for another device, its repeater regenerates the bits and passes them along the path.
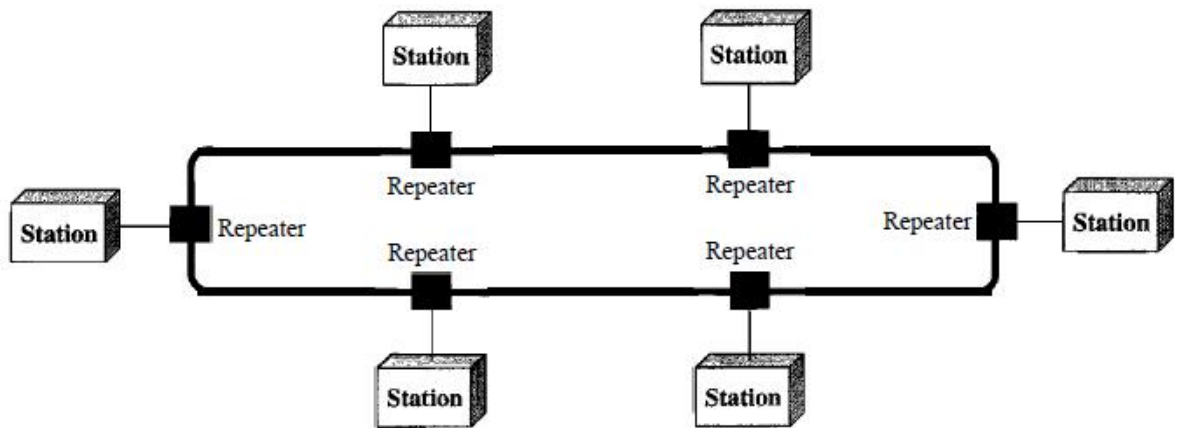

A ring is relatively easy to install and reconfigure. Each device is linked to only its immediate neighbors (either physically or logically). To add or delete a device requires changing only two connections. The only constraints are media and traffic considerations (maximum ring length and number of devices). In addition, fault isolation is simplified. Generally in a ring, a signal is circulating at all times. If one device does not receive a signal within a specified period, it can issue an alarm. The alarm alerts the network operator to the problem and its location.

However, unidirectional traffic can be a disadvantage. In a simple ring, a break in the ring (such as a disabled station) can disable the entire network. This weakness can be solved by using a dual ring or a switch capable of closing off the break.

STAR Topology:

In a star topology, each device has a dedicated point-to-point link only to a central controller, usually called a hub. The devices are not directly linked to one another. Unlike a mesh topology, a star topology does not allow direct traffic between devices. The controller acts as an exchange: If one device wants to send data to another, it sends the data to the controller, which then relays the data to the other connected device.
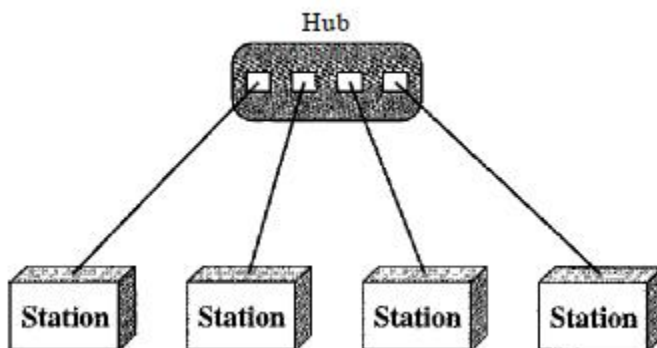
A star topology is less expensive than a mesh topology. In a star, each device needs only one link and one I/O port to connect it to any number of others. This factor also makes it easy to install and reconfigure. Far less cabling needs to be housed, and additions, moves, and deletions involve only one connection: between that device and the hub. Other advantages include robustness. If one link fails, only that link is affected. All other links remain active. This factor also lends itself to easy fault identification andfault isolation. As long as the hub is working, it can be used to monitor link problems and bypass defective links.

One big disadvantage of a star topology is the dependency of the whole topology on one single point, the hub. If the hub goes down, the whole system is dead.

Although a star requires far less cable than a mesh, each node must be linked to a central hub. For this reason, often more cabling is required in a star than in some other topologies (such as ring or bus). The star topology is used in local-area networks (LANs). High-speed LANs often use a star topology with a central hub.

2. **OSI Reference Model:**

The OSI model is a layered framework for the design of network systems that allows communication between all types of computer systems. It consists of seven separate but related layers, each of which defines a part of the process of moving information across a network.

The following figure shows the architecture of the OSI reference model:
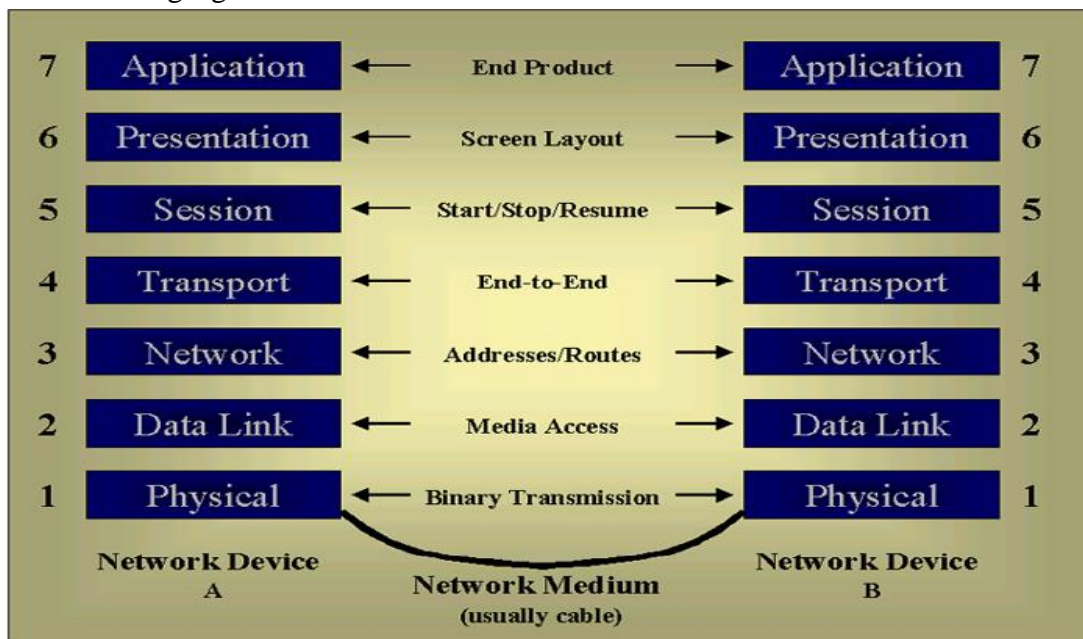
Application Layer: (Layer 7)

- **The application layer is responsible for providing services to the user.**

The application layer enables the user, whether human or software, to access the network. It provides user interfaces and support for services such as electronic mail, remote file access and transfer, shared database management, and other types of distributed information services.

Specific services provided by the application layer include the following:

Network virtual terminal: A network virtual terminal is a software version of a physical terminal, and it allows a user to log on to a remote host.

File transfer, access, and management: This application allows a user to access files in a remote host (to make changes or read data), to retrieve files from a remote computer for use in the local computer, and to manage or control files in a remote computer locally.

Mail services: This application provides the basis for e-mail forwarding and storage.

Directory services: This application provides distributed database sources and access for global information about various objects and services.

Presentation Layer: (Layer 6)

The presentation layer is responsible for translation, compression, and encryption.

Specific responsibilities of the presentation layer include the following:

- **Translation:** The information must be changed to bit streams before being transmitted. Because different computers use different encoding systems, the presentation layer is responsible for interoperability between these different encoding methods. The presentation layer at the sender changes the information from its sender-dependent format into a common format. The presentation layer at the receiving machine changes the common format into its receiver-dependent format.

- **Encryption:** To carry sensitive information, a system must be able to ensure privacy. Encryption means that the sender transforms the original information to another form and sends the resulting message out over the network. Decryption reverses the original process to transform the message back to its original form.

- **Compression:** Data compression reduces the number of bits contained in the information. Data compression becomes particularly important in the transmission of multimedia such as text, audio, and video.

Session Layer: (Layer 5)

The session layer is responsible for dialog control and synchronization.

The session layer is the network *dialog controller.* It establishes, maintains, and synchronizes the interaction among communicating systems.

Specific responsibilities of the session layer include the following:

- **Dialog control:** The session layer allows two systems to enter into a dialog. It allows the communication between two processes to take place in either half duplex (one way at a time) or full-duplex (two ways at a time) mode.
- **Synchronization:** Responsible for synchronizing the sender and the receiver.

Transport Layer (layer4):

The transport layer is responsible for process-to-process delivery of the entire message. A process is an application program running on a host.

The responsibilities of the transport layer include the following:

- **Service-point addressing (Port addressing):** Computers often run several programs at the same time. Each running program (process) must get identified by a unique service ID. The transport layer header must therefore include a type of address called a *service-point address* (or port address).
- **Segmentation and reassembly:** A message is divided into transmittable segments, with each segment containing a sequence number. These numbers enable the transport layer to reassemble the message correctly upon arriving at the destination and to identify and replace packets that were lost in transmission.
- **Connection control:** The transport layer can be either connectionless or connection oriented. A connectionless transport layer treats each segment as an independent packet and delivers it to the transport layer at the destination machine. A connection oriented transport

layer makes a connection with the transport layer at the destination machine first before delivering the packets. After all the data are transferred, the connection is terminated.

- **Flow control:** Responsible for end to end flow control.
- **Error control:** The transport layer is responsible for end to end error control in process transmission. Error correction is usually achieved through retransmission.

Network Layer (layer3):

The network layer is responsible for the delivery of individual packets from the source host to the destination host.

The responsibilities of the network layer include the following:

- **Logical addressing:** The network layer adds a header to the packet coming from the upper layer that, among other things, includes the logical addresses of the sender and receiver.

  It makes use of logical addresses called **Internet Protocol (IP) address**.
- **Routing:** It is the responsibility of the network layer to find the feasible route between the sender and the receiver using shortest path routing algorithms.

Data link Layer (Layer2):

The data link layer is responsible for moving frames from one hop (node) to the next.

Major responsibilities of the data link layer include the following:

- **Framing:** The data link layer divides the stream of bits received from the network layer into manageable data units called **frames.**
- **Physical addressing:** Data link Layer adds a header to each frame specifying the source and destination MAC (Medium Access Control) addresses of the communicating devices. MAC address is a physical address used to identify the machine in a LAN.
- **Flow control:** If the rate at which the data are absorbed by the receiver is less than the rate at which data are produced in the sender, the data link layer imposes a flow control mechanism to avoid overwhelming the receiver.
- **Error control:** The data link layer adds reliability to the physical layer by adding mechanisms to detect and retransmit damaged or lost frames. It also uses a mechanism to

recognize duplicate frames. Error control is normally achieved through a trailer added to the end of the frame.

- **Access control:** When two or more devices are connected to the same link, data link layer protocols are necessary to determine which device has control over the link at any given time.

Physical Layer: (Layer-1)

The physical layer is responsible for movements of individual bits from one hop (node) to the next.

The physical layer is also concerned with the following:

- **Physical characteristics of interfaces and medium:** The physical layer defines the characteristics of the interface between the devices and the transmission medium. It also defines the type of transmission medium

- **Representation of bits:** The physical layer data consists of a stream of bits (sequence of Os or 1s) with no interpretation. To be transmitted, bits must be encoded into signals--electrical or optical. The physical layer defines the type of encoding (how Os and I s are changed to signals).

- **Data rate:** The transmission rate-the number of bits sent each second-is also defined by the physical layer. In other words, the physical layer defines the duration of a bit, which is how long it lasts.

- **Synchronization of bits:** The sender and the receiver clocks must be synchronized.

- **Line configuration:** The physical layer is concerned with the connection of devices to the media. In a point-to-point configuration, two devices are connected through a dedicated link. In a multipoint configuration, a link is shared among several devices.

- **Physical topology:** The physical topology defines how devices are connected to make a network. Devices can be connected by using a mesh topology (every device is connected to every other device), a star topology (devices are connected through a central device), a ring topology (each device is connected to the next, forming a ring), a bus topology (every device is on a common link), or a hybrid topology (this is a combination of two or more topologies).

- **Transmission mode:** The physical layer also defines the direction of transmission between two devices: simplex, half-duplex, or full-duplex.

3 a. **A local area network (LAN):** is usually privately owned and links the devices in a single office, building, or campus (see Figure 1.10). Depending on the needs of an organization and the type of technology used, a LAN can be as simple as two PCs and a printer in someone's home office; or it can extend throughout a company and include audio and video peripherals. Currently, LAN size is limited to a few kilometers.

LANs are designed to allow resources to be shared between personal computers or workstations. The resources to be shared can include hardware (e.g., a printer), software (e.g., an application program), or data. A common example of a LAN, found in many business environments, links a workgroup of task-related computers, for example, engineering workstations or accounting PCs. One of the computers may be given a large capacity disk drive and may become a server to clients. Software can be stored on this central server and used as needed by the whole group. In this example, the size of the LAN may be determined by licensing restrictions on the number of users per copy of software, or by restrictions on the number of users licensed to access the operating system. In addition to size, LANs are distinguished from other types of networks by their transmission media and topology. In general, a given LAN will use only one type of transmission medium. The most common LAN topologies are bus, ring, and star.

Wide Area Network:

A wide area network (WAN) provides long-distance transmission of data, image, audio, and video information over large geographic areas that may comprise a country, a continent, or even the whole world. A WAN can be as complex as the backbones that connect the Internet or as simple as a dial-up line that connects a home computer to the Internet. We normally refer to the first as a switched WAN and to the second as a point-to-point WAN. The switched WAN connects the end systems, which usually comprise a router (internetworking connecting device) that connects to another LAN or WAN. The point-to-point WAN is normally a line leased from a telephone or cable TV provider that connects a home computer or a small LAN to an Internet service provider (lSP). This type of WAN is often used to provide Internet access.

Metropolitan Area Network :

A metropolitan area network (MAN) is a network with a size between a LAN and a WAN. It normally covers the area inside a town or a city. It is designed for customers who need a high-speed

connectivity, normally to the Internet, and have endpoints spread over a city or part of city. A good example of a MAN is the part of the telephone company network that can provide a high-speed DSL line to the customer. Another example is the cable TV network that originally was designed for cable TV, but today can also be used for high-speed data connection to the Internet.

3 b). No. of Cables: 45

No. of ports per device:09

4. The different Line coding schemes are listed as given below:

- Unipolar encoding
  - o NRZ

- Polar
  - o NRZ-L
  - o NRZ-I
  - o RZ
  - o Manchester
  - o Differential Manchester

- Bipolar
  - o AMI
  - o Pseudo ternary

Given Data stream: 101011100

(The Waveforms are to be written)

5. Transmission Impairments:

Signals travel through transmission media, which are not perfect. The imperfection causes signal impairment. This means that the signal at the beginning of the medium is not the same as the signal at the end of the medium. What is sent is not what is received. Three causes of impairment are attenuation, distortion, and noise

Attenuation means a loss of energy. When a signal, simple or composite, travels through a medium, it loses some of its energy in overcoming the resistance of the medium. That is why a wire carrying electric signals gets warm, if not hot, after a while. Some of the electrical energy in

the signal is converted to heat. To compensate for this loss, amplifiers are used to amplify the signal. Figure given below shows the effect of attenuation and amplification.
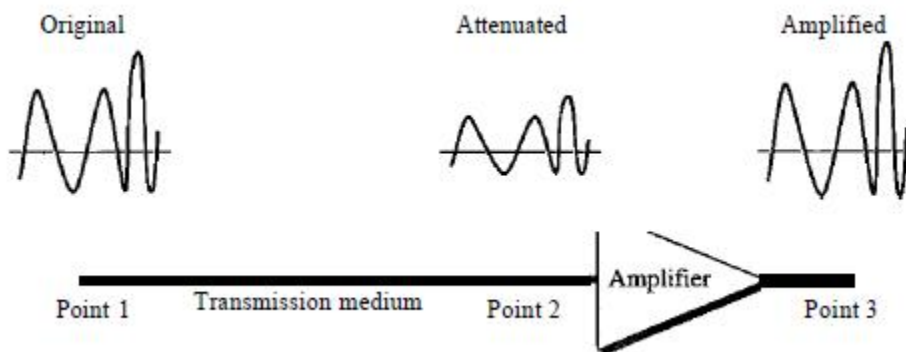

Distortion

Distortion means that the signal changes its form or shape. Distortion can occur in a composite signal made of different frequencies. Each signal component has its own propagation speed (see the next section) through a medium and, therefore, its own delay in arriving at the final destination. Differences in delay may create a difference in phase if the delay is not exactly the same as the period duration. In other words, signal components at the receiver have phases different from what they had at the sender. The shape of the composite signal is therefore not the same. Figure given below shows the effect of distortion on a composite signal.
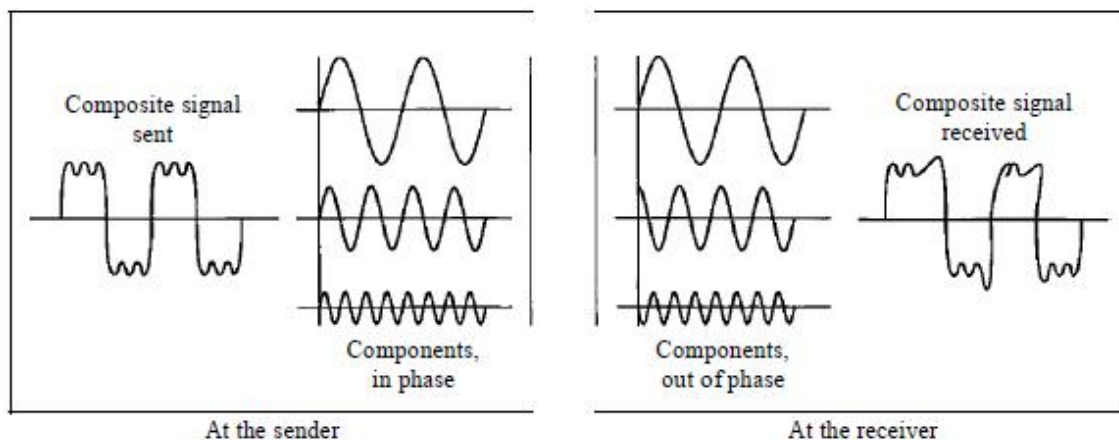

Noise

Noise is another cause of impairment. Several types of noise, such as thermal noise, induced noise, crosstalk, and impulse noise, may corrupt the signal. Thermal noise is the random motion of electrons in a wire which creates an extra signal not originally sent by the transmitter. Induced noise comes from sources such as motors and appliances. These devices act as a sending antenna, and the transmission medium acts as the receiving antenna. Crosstalk is the effect of

one wire on the other. One wire acts as a sending antenna and the other as the receiving antenna. Impulse noise is a spike (a signal with high energy in a very short time) that comes from power lines, lightning, and so on. Figure given below shows the effect of noise on a signal.
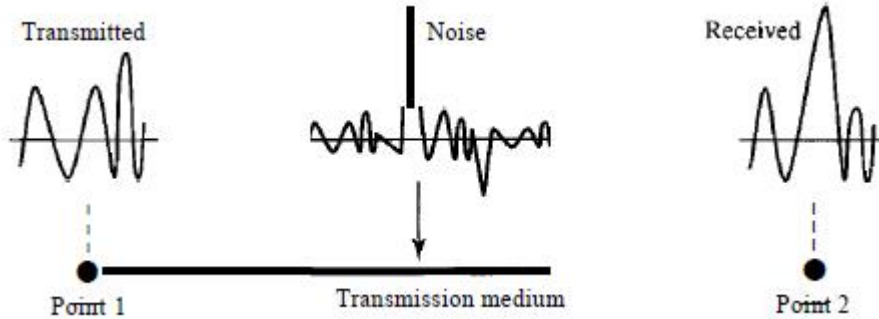
6. *Binary FSK (BFSK)*

consider two carrier frequencies f1andf2, the first carrier ifthe data element is 0; we use the second if the data element is 1. the middle of one bandwidth is f1 and the middle of the other is f2. Both f1 and f2 are f apart from the midpoint between the two bands. The difference between the two frequencies is *211f*
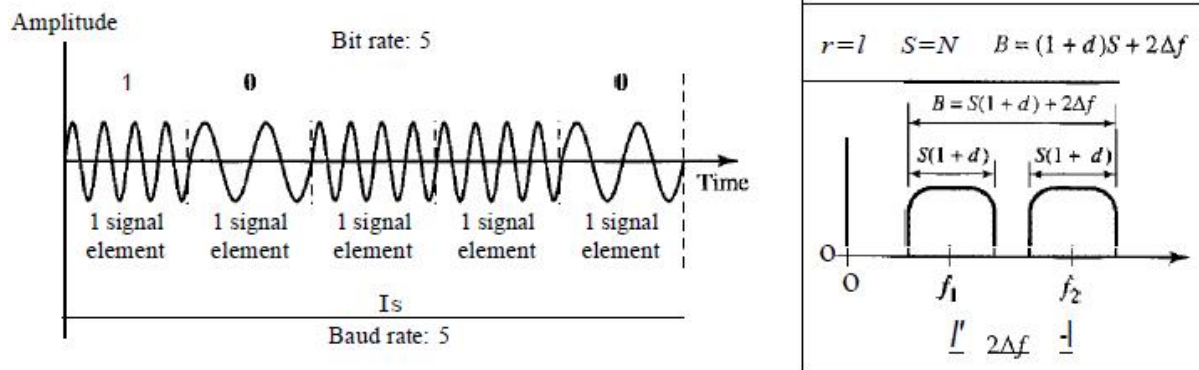

Quadrature PSK (QPSK)

 The simplicity of BPSK enticed designers to use 2 bits at a time in each signal element, thereby decreasing the baud rate and eventually the required bandwidth. The scheme is called quadrature PSK or QPSK because it uses two separate BPSK modulations; one is in-phase, the other quadrature (out-of-phase). The incoming bits are first passed through a serial-to-parallel conversion that sends one bit to one modulator and the next

bit to the other modulator. If the duration of each bit in the incoming signal is *T,* the duration of each bit sent to the corresponding BPSK signal is *2T.*

The two composite signals created by each multiplier are sine waves with the same frequency, but different phases. When they are added, the result is another sine wave, with one of four possible phases: *45°, -45°, 135°,* and *-135°.* There are four kinds of signal elements in the output signal *(L = 4),* so we can send 2 bits per signal element *(r =2).*
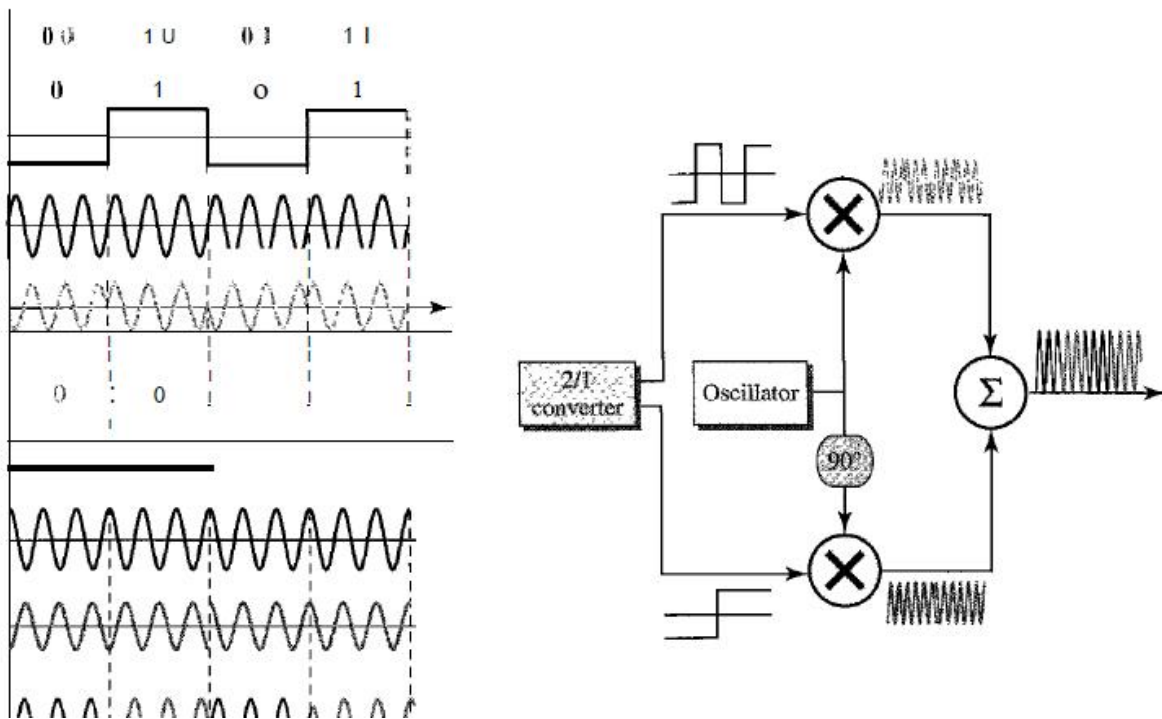

7. *FDM*

Frequency-division multiplexing (FDM) is an analog technique that can be applied when the bandwidth of a link (in hertz) is greater than the combined bandwidths of the signals to be transmitted. Carrier frequencies are separated by sufficient bandwidth to accommodate the modulated signal. Channels can be separated by strips of unused bandwidth-guard bands-to prevent signals from overlapping.

Multiplexing Process

Each source generates a signal of a similar frequency range. Inside the multiplexer, these similar signals modulates different carrier frequencies (/1,12, and h). The resulting modulated signals are then combined into a single composite signal that is sent out over a media link that has enough bandwidth to accommodate it.
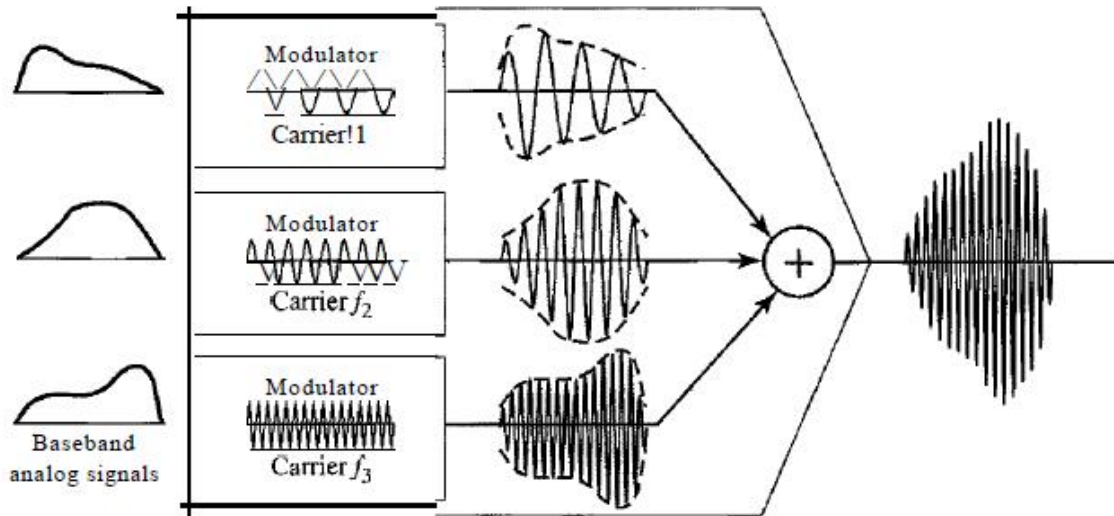
Demultiplexing Process

The demultiplexer uses a series of filters to decompose the multiplexed signal into its constituent component signals. The individual signals are then passed to a demodulator that separates them from their carriers and passes them to the output lines.
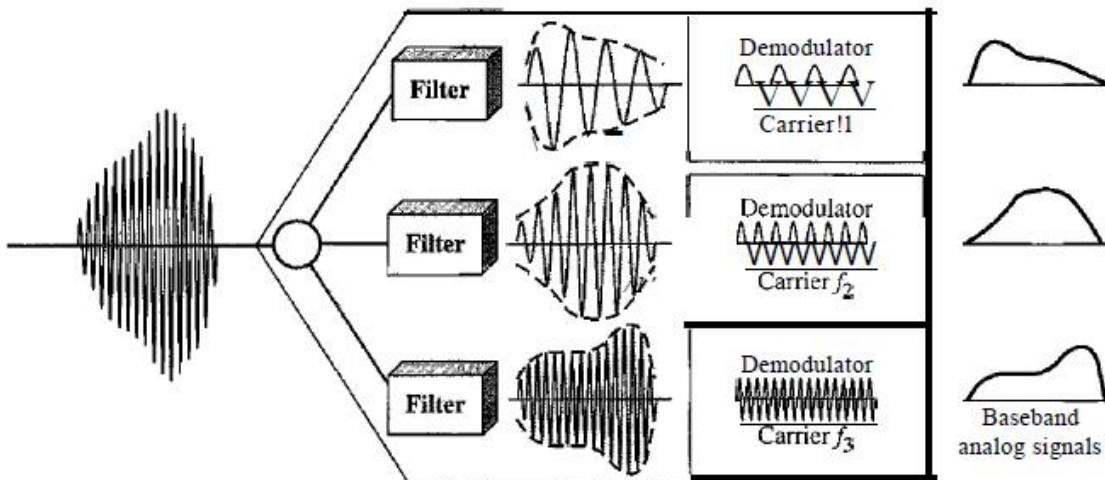
b) For Eight channels, we need at least seven guard bands. This means that the required bandwidth is at

least 8 x 200 + 7 x 8 =1656 kHz

8a) Bw=4kHz

$$=4*10^3Hz$$

Signal=10V, Noise=$5*10^{-3}$V

SNR=$10/5*10^{-3}$

$$=2*10^3$$

Shannon capacity, C=Blog$_2$(1+SNR)

$$=4*10^3* \log_2[1+2000]$$

$$=43866bps$$

b)   dB=10 log$_{10}$ P2/P1

so, dB=10 log$_{10}$ (100/90)

$$= 0.4575749 \text{ dB}$$

c)   Bandwidth= High frequency-Low frequency(f_h-f_l)

So, Bandwidth=200-10

$$=190Hz$$