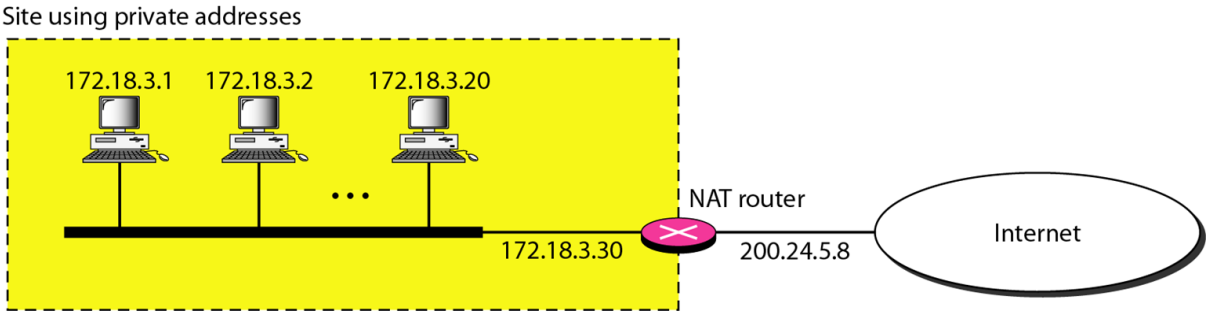
COMPUTER COMMUNICATIONS

PART – B (10 MARKS) QUESTIONS

1) Explain the network address translation with neat diagram

NAT – Network Address Translation

- It is the way that the router *translates* the IP addresses of packets that cross the internet/local network boundary.
    - When computer "A" sends a packet out "from" that of computer "A" – 192.168.1.2. When the router passes that packet on to the internet, it replaces the local IP address with the internet IP address assigned by the ISP.
    - It also keeps track, so that if a response comes back from somewhere on the internet, the router knows to do the translation in reverse – replace the internet IP address with the local IP address for machine "A" and then send that response packet on to machine "A".
- NAT is not restricted to private-to-public address translation, though that is the most common application.
- NAT can also perform public-to-public address translation, as well as private-to-private address translation.



2) PROBLEMS –SUBNETTING NUMERALS:

* FIXED LENGTH SUBNET MASK (FLSM - EQUAL SIZED SUBNETS)

CLASSLESS ADDRESSING:

Q 1) Using Class "C" Address:

An organization is granted with the IP address 192.16.2.0/24. The administrator wants to create 4 Subnets. Calculate the following.

1) Find the Subnet Mask
2) No. of hosts in each Subnet
3) First and Last host address of each Subnet.
4) Network and Broadcast address of each Subnet.

SOLUTION:

Given is class "C" address

192.16.2.0/24

Need to Create 4 Subnets.

To find "n": $2^n \geq$ No. of Subnets

$2^n \geq 4$

No. of network bits $n = 2$

$n \Rightarrow$ No. of host bits to be borrowed.

$\therefore$ '2' bits to be borrowed.

1) To find Subnet Mask:

192.16.2.00 000000 / 26

(2 bits borrowed)

Net id | Host id

$\therefore$ Subnet Mask is

11111111.11111111.11111111.11000000

(or) 255.255.255.192

2) To find no. of hosts in each Subnet(h):

No. of host bits (h) = 6

$\therefore$ Total No. of hosts $= 2^6 = 64$

No. of usable (or) Valid hosts = $64 - 2$ (Excluding Network + Broadcast address)

$= 62$

3) To find the First host, Last host, Network and Broadcast Address:

192.16.2.[00]000000

Remains Unchanged

0 1
1 0
1 1

$\Rightarrow$ Four Subnets.

* Subnet (1) : 00

Net id : 192.16.2.00000000

192.16.2.0/26

Broadcast : 192.16.2.00111111

192.16.2.63/26

$\therefore$ First Host : 192.16.2.1/26

Last Host : 192.16.2.62/26

* Sub-net (2) ...

* Subnet ② : 01

Net id : 192.16.2.01|000000

192.16.2.64/26

Broadcast : 192.16.2.01/111111

192.16.2.127/26

First Host : 192.16.2.65/26

Last Host : 192.16.2.126/26

* Subnet ③ : 10

Net id : 192.16.2.10/000000

192.16.2.128/26

Broadcast : 192.16.2.01/111111

192.16.2.191/26

First Host : 192.16.2.129/26

Last Host : 192.16.2.190/26

* Subnet ④ : 11

Net id : 192.16.2.11 /000000

192.16.2.192/26

Broadcast : 192.16.2.11/111111

192.16.2.255/26

First Host : 192.16.2.193/26

Last Host : 192.16.2.254/26

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2) Using class "B" address

IPaddress : 172.168.0.0/16

Create 32 Subnets.

To find n :

$2^n \geq 32$

$\boxed{n = 5}$

172.168.00000/000.000

1) To find Subnet Mask :

255.255.248.0

11111111.11111111.11111000.00000000

2) To find the number of hosts in each subnet.

No. of host bits = 11 bits

∴ Total No. of hosts = 2^{11} = 2048

No. of usable hosts = 2048 − 2 = 2046

3) To find the network, Broadcast, First Host and Last Host address of first and Last Subnet

a) Subnet 00000 : [FIRST SUBNET]

Net id : 172.168. 00000/000.00000000

172.168.0.0

First Host id : 172.168.1.0

Last Host id : 172.168.6.254

Broadcast id : 172.168. 00000/111.11111111

172.168.7.255

b) Subnet 11111 : [LAST SUBNET]

Net id : 172.168. 11111/000.00000000

172.168.248.0

First Host id : 172.168.248.1

Last Host id : 172.168.255.254

Broadcast id : 172.168. 11111/111.11111111

172.168.255.255

Q3) Using class A Address:

An organization is granted with IP address 10.0.0.0/21. The administrator wants to create 200 fixed length subnets.

(i) First and Last Network's Address

(ii) Usable first and last host ID for the first and last network

(iii) Broadcast id for the first & Last Network.

(iv) How many no. of hosts possible to connect in each network.

SOLUTION: N/w address

(i) Subnet 1: 10.0.0.0

Subnet 200: 10.0.00000110.00111
199

(ie) 10.0.6.56

200 no. of subnet means from 0 to 199

(ii) First network

FH : 10.0.0.1

LH : 10.0.0.6

FH - First Host

LH - Last Host

No. of hosts in each Subnet $= 2^h = 2^3 = 8$

So 10.0.0.0 to 10.0.0.7

FH is => 10.0.0.1

LH is => 10.0.0.6

LAST SUBNET:

LAST SUBNET:

FH : 10.0.6.57

LH : 10.0.6.62

(iii) Broadcast id:

For First Subnet : 10.0.0.7

For Last Subnet (200th) : 10.0.6.63

(iv) How many hosts?

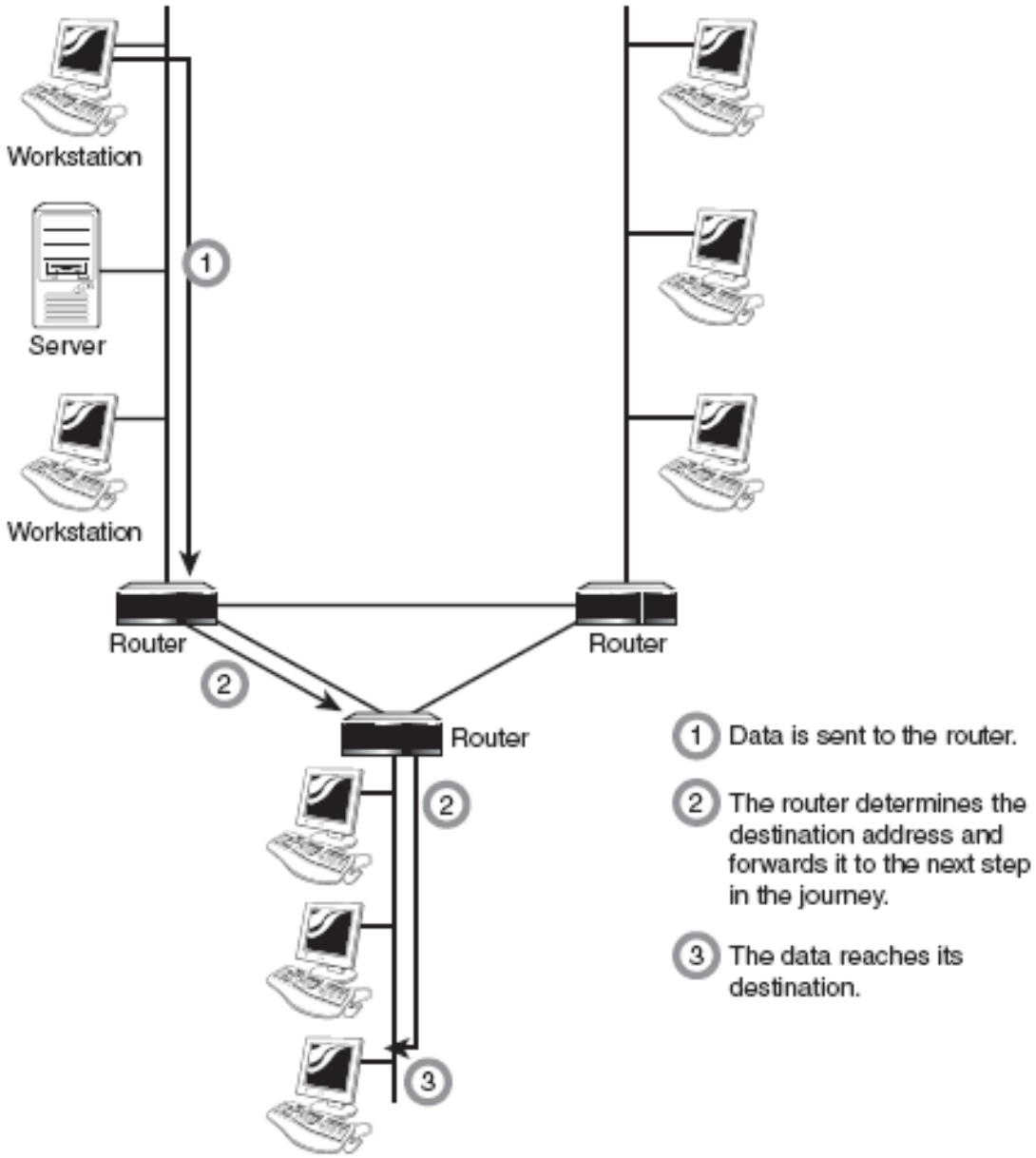
$2^n = 2^3 =$ 8 hosts.

3) Define Router and explain its functionalities in detail

Router:

- Routers are network devices that literally route data around the network.
- By examining data as it arrives, the router can determine the destination address for the data; then, by using tables of defined routes, the router determines the best way for the data to continue its journey.
- Router is mainly a Network Layer device. Routers normally connect LANs and WANs together.

FIGURE 3.12 The basic function of a router.



4) Explain the working principle and applications of hub and switch.

Working Principle of Hub :

Hubs work as a central connection between all network equipment and handle a data type, which is called frames. If a frame is received, it is transmitted to the port of the destination computer after amplifying it. A frame is passed to each of its ports in the hub, whether it is destined only for one port. It does not include the way of deciding a frame to which port it should be sent. Therefore, a frame has to transmit to every port, which ensures that it will reach its intended destination that generates a lot of traffic on the network and can be caused to damage the network. The hub is slower

as compared to standard switch as it is not able to send or receive information at the same time, but a switch is more costly than a hub.

The important applications of a hub are given below:

- Hub is used to create small home networks.
- It is used for network monitoring.
- They are also used in organizations to provide connectivity.
- It can be used to create a device that is available thought out of the network.

Working Principle of Switch :

When the source wants to send the data packet to the destination, packet first enters the switch and the switch reads its header and find the MAC address of destination to identify the device then it sends the packet out through the appropriate ports that leads to the destination devices.

Switch establishes a temporary connection between source and destination for communication and terminates the connection once conversation is done. Also, it offers full bandwidth to network traffic going to and from a device at the same time to reduce collision.

Applications of Switch :

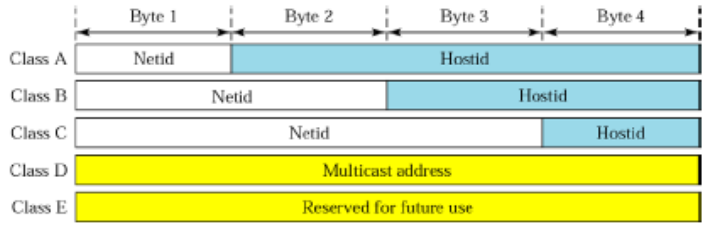
- Switches are used to forward the packets based on MAC addresses.
- A Switch is used to transfer the data only to the device that has been addressed. It verifies the destination address to route the packet appropriately.

5) Discuss the classful; addressing with relevant examples.

Classful IP Addressing

Classful IP Addressing – supports addressing of different size networks by dividing address space into 5 classes: A, B, C, D, E

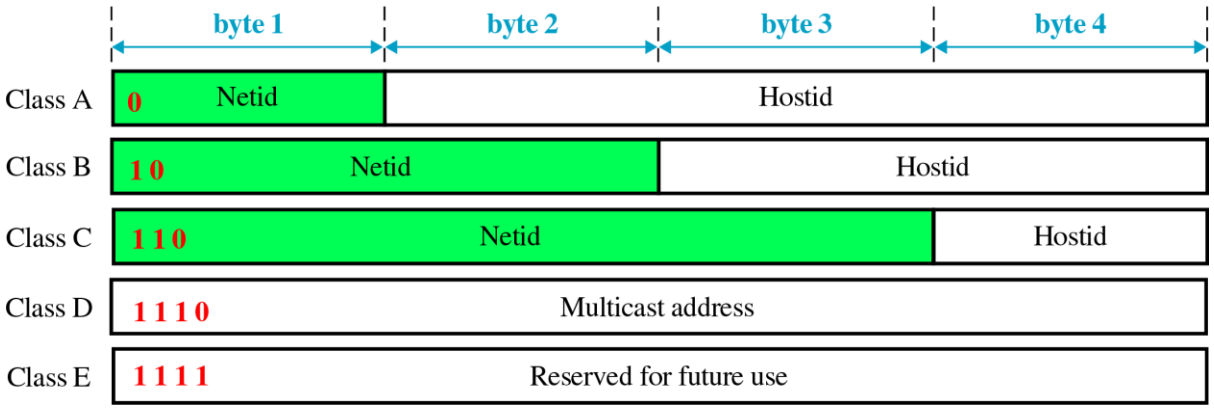
- an IP address in classes A, B, and C is divided into Netid and Hostid
- class A addresses (1-byte Netid): get assigned to organizations with a large number of hosts or routers – there are only 126 class A networks with up to 16 million hosts in each
- class B addresses (2-byte Netid): allow around 16,000 networks and around 64,000 hosts per each network
- class C addresses (3-byte Netid): allow around 2 million networks and around 254 hosts per each network



While many class A and B addresses are wasted, the number of addresses in class C is smaller than the needs of most organizations.

How do we know if an IP address is a class-A / B or C!?

- In classful addressing, the address space is divided into five classes: A, B, C, D, and E.



6) Illustrate Line Coding and its types with neat diagram.

Line Coding

A **line code** is the code used for data transmission of a digital signal over a transmission line. This process of coding is chosen so as to avoid overlap and distortion of signal such as inter-symbol interference.

Types of Line Coding

There are 3 types of Line Coding

- Unipolar
- Polar
- Bi-polar

Unipolar Signaling

Unipolar signaling is also called as On-Off Keying or simply OOK.

The presence of pulse represents a 1 and the absence of pulse represents a 0.

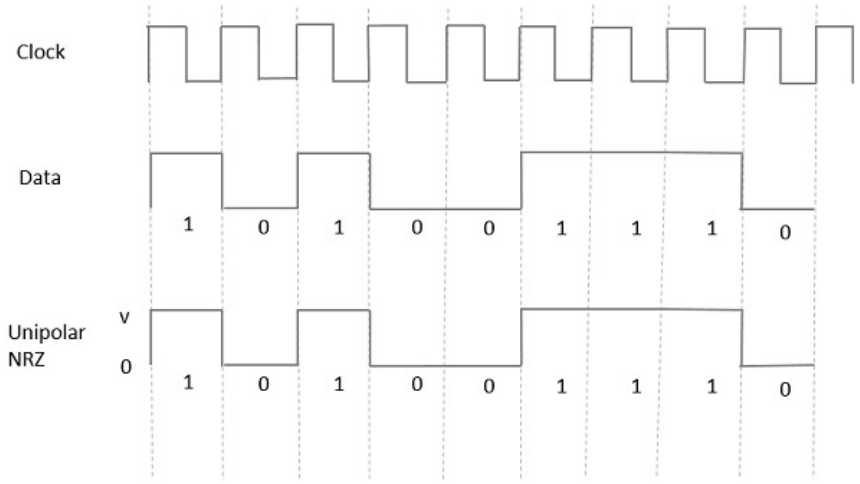
There are two variations in Unipolar signaling −

- Non Return to Zero NRZNRZ
- Return to Zero RZRZ

Unipolar Non-Return to Zero NRZNRZ

In this type of unipolar signaling, a High in data is represented by a positive pulse called as **Mark**, which has a duration T_0 equal to the symbol bit duration. A Low in data input has no pulse.

The following figure clearly depicts this.



Advantages

The advantages of Unipolar NRZ are −

- It is simple.
- A lesser bandwidth is required.

Disadvantages

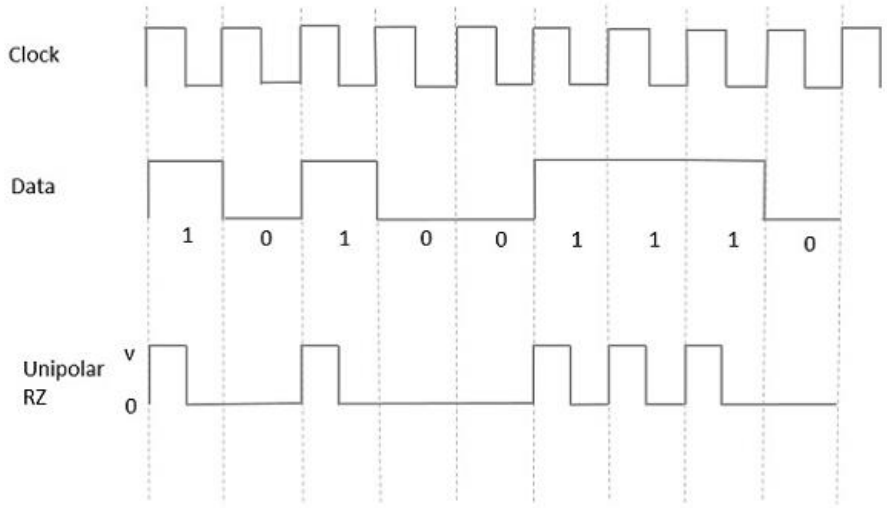
The disadvantages of Unipolar NRZ are −

- No error correction done.
- Presence of low frequency components may cause the signal droop.
- No clock is present.
- Loss of synchronization is likely to occur (especially for long strings of **1s** and **0s**).

Unipolar Return to Zero RZRZ

In this type of unipolar signaling, a High in data, though represented by a **Mark pulse**, its duration $\mathbf{T_0}$ is less than the symbol bit duration. Half of the bit duration remains high but it immediately returns to zero and shows the absence of pulse during the remaining half of the bit duration.

It is clearly understood with the help of the following figure.



Advantages

The advantages of Unipolar RZ are −

- It is simple.
- The spectral line present at the symbol rate can be used as a clock.

Disadvantages

The disadvantages of Unipolar RZ are −

- No error correction.
- Occupies twice the bandwidth as unipolar NRZ.
- The signal droop is caused at the places where signal is non-zero at 0 Hz.

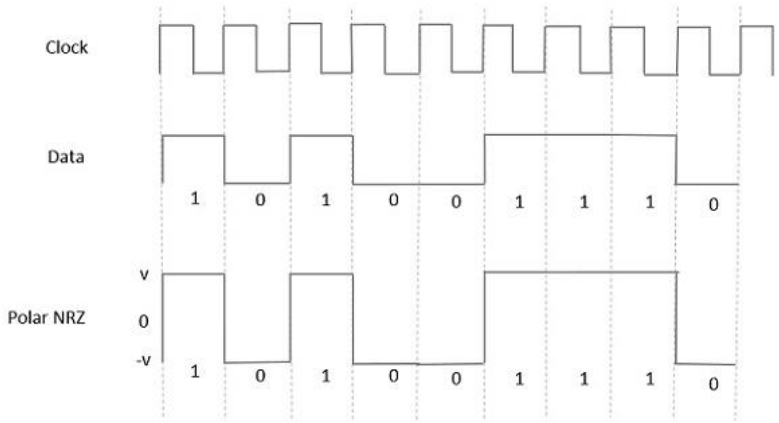
Polar Signaling

There are two methods of Polar Signaling. They are −

- Polar NRZ
- Polar RZ

Polar NRZ

In this type of Polar signaling, a High in data is represented by a positive pulse, while a Low in data is represented by a negative pulse. The following figure depicts this well.



Advantages

The advantages of Polar NRZ are −

- It is simple.
- No low-frequency components are present.

Disadvantages

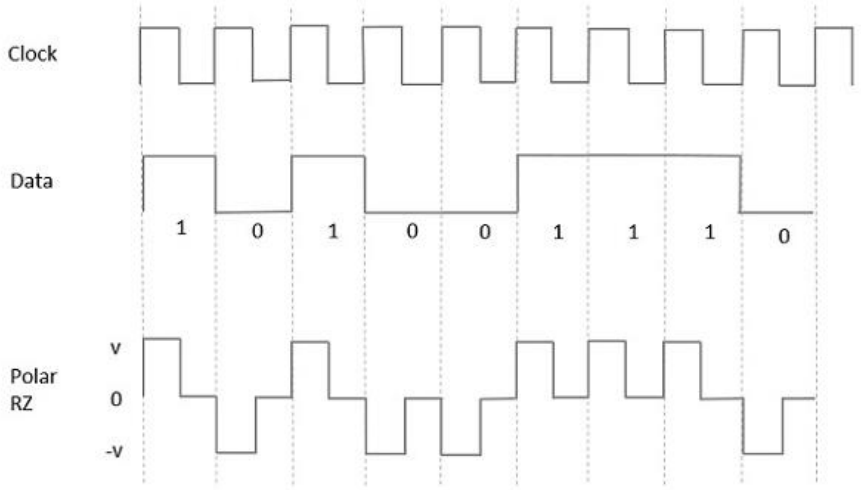
The disadvantages of Polar NRZ are −

- No error correction.
- No clock is present.
- The signal droop is caused at the places where the signal is non-zero at **0 Hz**.

Polar RZ

In this type of Polar signaling, a High in data, though represented by a **Mark pulse**, its duration $\mathbf{T_0}$ is less than the symbol bit duration. Half of the bit duration remains high but it immediately returns to zero and shows the absence of pulse during the remaining half of the bit duration.

However, for a Low input, a negative pulse represents the data, and the zero level remains same for the other half of the bit duration. The following figure depicts this clearly.



Advantages

The advantages of Polar RZ are −

- It is simple.
- No low-frequency components are present.

Disadvantages

The disadvantages of Polar RZ are −

- No error correction.
- No clock is present.
- Occupies twice the bandwidth of Polar NRZ.
- The signal droop is caused at places where the signal is non-zero at **0 Hz**.

7) Explain the neat sketch the unguided media of computer transmission

UnGuided Media

Unguided medium transport electromagnetic waves without using a physical conductor. This type of communication is often referred to as wireless communication. Signals are normally broadcast through free space and thus are available to anyone who has a device capable of receiving them.

Unguided signals can travel from the source to the destination in several ways: **Gound propagation**, **Sky propagation** and **Line-of-sight propagation**

- **Ground Propagation:** In this, radio waves travel through the lowest portion of the atmosphere, hugging the Earth. These low-frequency signals emanate in all directions from the transmitting antenna and follow the curvature of the planet.

- **Sky Propagation:** In this, higher-frequency radio waves radiate upward into the ionosphere where they are reflected back to Earth. This type of transmission allows for greater distances with lower output power.
- **Line-of-sight Propagation:** in this type, very high-frequency signals are transmitted in straight lines directly from antenna to antenna.

We can divide wireless transmission into three broad groups:

1. **Radio waves**
2. **Micro waves**
3. **Infrared waves**

Radio Waves:

Electromagnetic waves ranging in frequencies between 3 KHz and 1 GHz are normally called radio waves.

Radio waves are omnidirectional. When an antenna transmits radio waves, they are propagated in all directions. This means that the sending and receiving antennas do not have to be aligned. A sending antenna send waves that can be received by any receiving antenna. The omnidirectional property has disadvantage, too. The radio waves transmitted by one antenna are susceptible to interference by another antenna that may send signal suing the same frequency or band.

Radio waves, particularly with those of low and medium frequencies, can penetrate walls. This characteristic can be both an advantage and a disadvantage. It is an advantage because, an AM radio can receive signals inside a building. It is a disadvantage because we cannot isolate a communication to just inside or outside a building.

Omnidirectional Antenna for Radio Waves

Radio waves use omnidirectional antennas that send out signals in all directions.

Applications of Radio Waves

- The omnidirectional characteristics of radio waves make them useful for multicasting in which there is one sender but many receivers.
- AM and FM radio, television, maritime radio, cordless phones, and paging are examples of multicasting.

Micro Waves

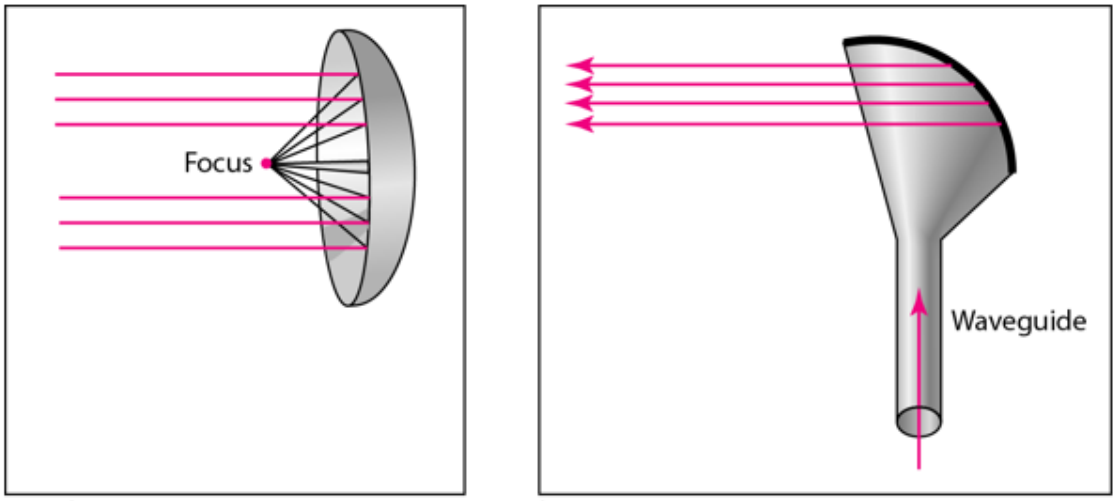
Electromagnetic waves having frequencies between 1 and 300 GHz are called micro waves. Micro waves are unidirectional. When an antenna transmits microwaves, they can be narrowly focused. This means that the sending and receiving antennas need to be aligned. The unidirectional property has an obvious advantage. A pair of antennas can be aligned without interfering with another pair of aligned antennas.

The following describes some characteristics of microwaves propagation:

- Microwave propagation is line-of-sight. Since the towers with the mounted antennas need to be in direct sight of each other, towers that are far apart need to be very tall.
- Very high-frequency microwaves cannot penetrate walls. This characteristic can be a disadvantage if receivers are inside the buildings.
- The microwave band is relatively wide, almost 299 GHz. Therefore, wider sub-bands can be assigned and a high date rate is possible.
- Use of certain portions of the band requires permission from authorities.

Unidirectional Antenna for Micro Waves

Microwaves need unidirectional antennas that send out signals in one direction. Two types of antennas are used for microwave communications: **Parabolic Dish** and **Horn**.



a. Dish antenna b. Horn antenna

A parabolic antenna works as a funnel, catching a wide range of waves and directing them to a common point. In this way, more of the signal is recovered than would be possible with a single-point receiver.

A horn antenna looks like a gigantic scoop. Outgoing transmissions are broadcast up a stem and deflected outward in a series of narrow parallel beams by the curved head. Received transmissions are collected by the scooped shape of the horn, in a manner similar to the parabolic dish, and are deflected down into the stem.

Applications of Micro Waves

Microwaves, due to their unidirectional properties, are very useful when unicast(one-to-one) communication is needed between the sender and the receiver. They are used in cellular phones, satellite networks and wireless LANs.

There are 2 types of Microwave Transmission :

1. Terrestrial Microwave
2. Satellite Microwave

Advantages of Microwave Transmission

- Used for long distance telephone communication
- Carries 1000's of voice channels at the same time

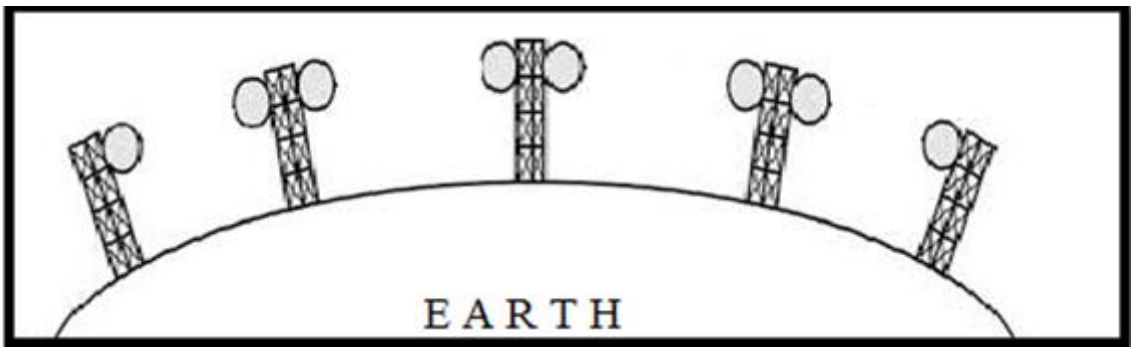
Disadvantages of Microwave Transmission

- It is very costly

Terrestrial Microwave

For increasing the distance served by terrestrial microwave, repeaters can be installed with each antenna .The signal received by an antenna can be converted into transmittable form and

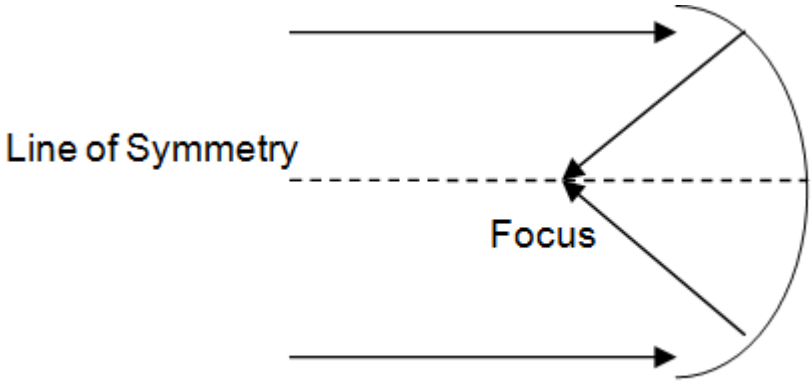
relayed to next antenna as shown in below figure. It is an example of telephone systems all over the world



There are **two types of antennas** used for terrestrial microwave communication :

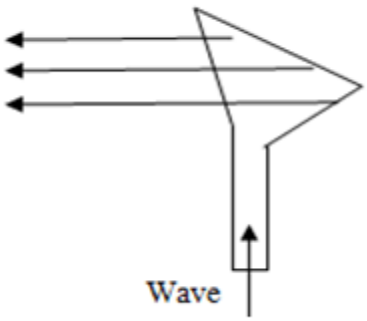
1. Parabolic Dish Antenna

In this every line parallel to the line of symmetry reflects off the curve at angles in a way that they intersect at a common point called focus. This antenna is based on geometry of parabola.



2. Horn Antenna

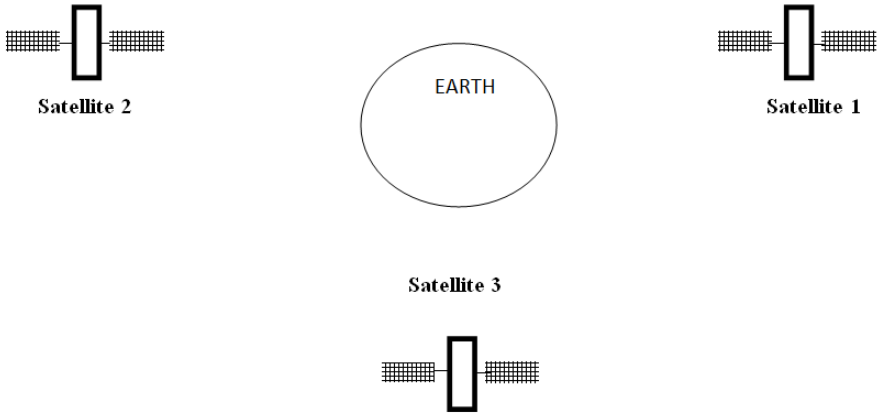
It is a like gigantic scoop. The outgoing transmissions are broadcast up a stem and deflected outward in a series of narrow parallel beams by curved head.



Satellite Microwave

This is a microwave relay station which is placed in outer space. The satellites are launched either by rockets or space shuttles carry them.

These are positioned 36000 Km above the equator with an orbit speed that exactly matches the rotation speed of the earth. As the satellite is positioned in a geo-synchronous orbit, it is stationery relative to earth and always stays over the same point on the ground. This is usually done to allow ground stations to aim antenna at a fixed point in the sky.



8) Guided Media

Guided Media

Types Of Guided media:

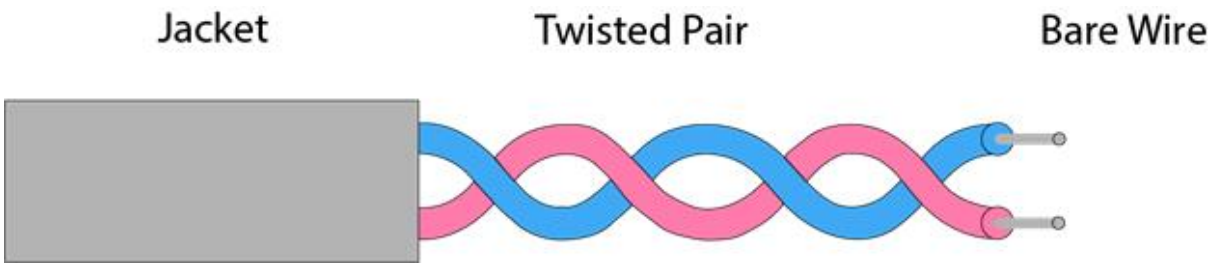
1. **Twisted pair:**
2. **Co-axial cable**
3. **Optical fibre cable**

Twisted pair:

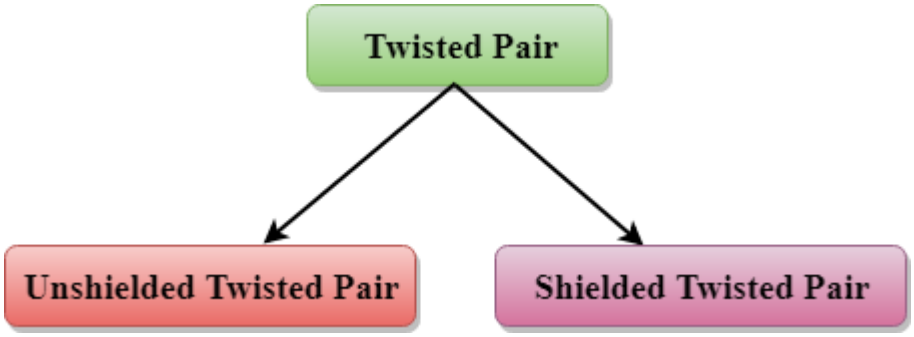
Twisted pair is a physical media made up of a pair of cables twisted with each other. A twisted pair cable is cheap as compared to other transmission media. Installation of the twisted pair cable is easy, and it is a lightweight cable. The frequency range for twisted pair cable is from 0 to 3.5KHz.

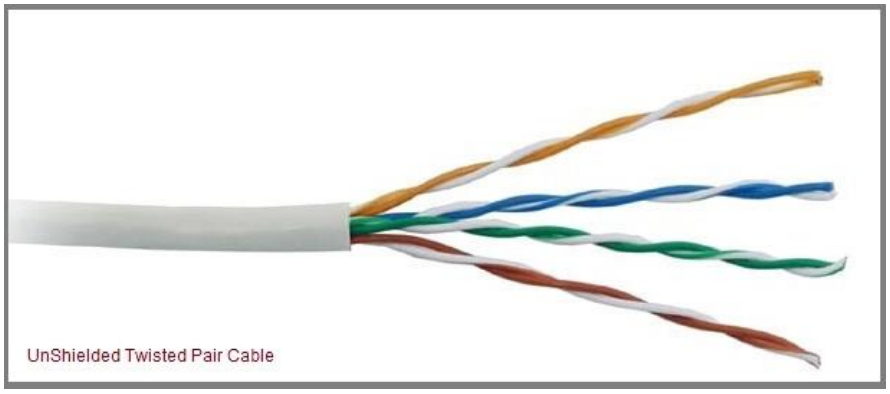
A twisted pair consists of two insulated copper wires arranged in a regular spiral pattern.

The degree of reduction in noise interference is determined by the number of turns per foot. Increasing the number of turns per foot decreases noise interference.



Types of Twisted pair:





Unshielded Twisted Pair:

An unshielded twisted pair is widely used in telecommunication. Following are the categories of the unshielded twisted pair cable:

- **Category 1:** Category 1 is used for telephone lines that have low-speed data.
- **Category 2:** It can support upto 4Mbps.
- **Category 3:** It can support upto 16Mbps.
- **Category 4:** It can support upto 20Mbps. Therefore, it can be used for long-distance communication.
- **Category 5:** It can support upto 200Mbps.

Advantages Of Unshielded Twisted Pair:

- It is cheap.

- Installation of the unshielded twisted pair is easy.
- It can be used for high-speed LAN.

Disadvantage:

- This cable can only be used for shorter distances because of attenuation.

Shielded Twisted Pair

A shielded twisted pair is a cable that contains the mesh surrounding the wire that allows the higher transmission rate.

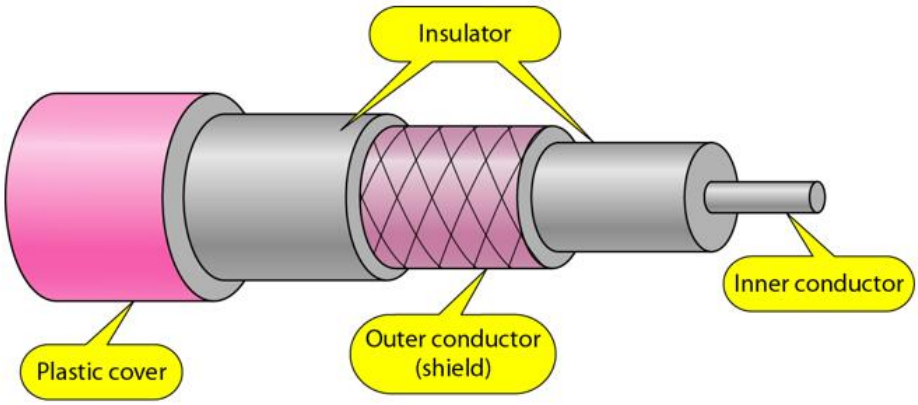
Characteristics Of Shielded Twisted Pair:

- The cost of the shielded twisted pair cable is not very high and not very low.
- An installation of STP is easy.
- It has higher capacity as compared to unshielded twisted pair cable.
- It has a higher attenuation.
- It is shielded that provides the higher data transmission rate.

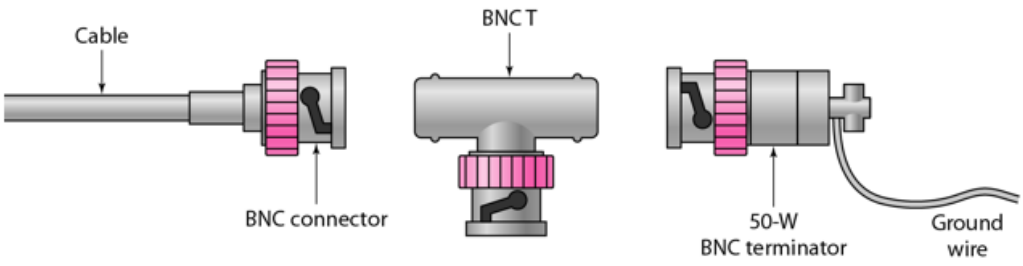
Disadvantages

- It is more expensive as compared to UTP and coaxial cable.
- It has a higher attenuation rate.

Coaxial Cable



- Coaxial cable is very commonly used transmission media, for example, TV wire is usually a coaxial cable.
- The name of the cable is coaxial as it contains two conductors parallel to each other.
- It has a higher frequency as compared to Twisted pair cable.
- The inner conductor of the coaxial cable is made up of copper, and the outer conductor is made up of copper mesh. The middle core is made up of non-conductive cover that separates the inner conductor from the outer conductor.
- The middle core is responsible for the data transferring whereas the copper mesh prevents from the **EMI**(Electromagnetic interference).



Advantages Of Coaxial cable:

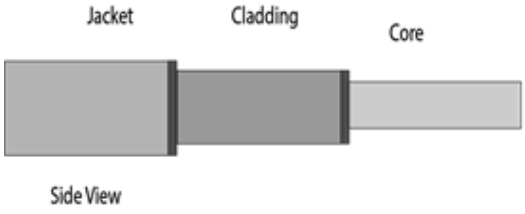
- The data can be transmitted at high speed.
- It has better shielding as compared to twisted pair cable.
- It provides higher bandwidth.

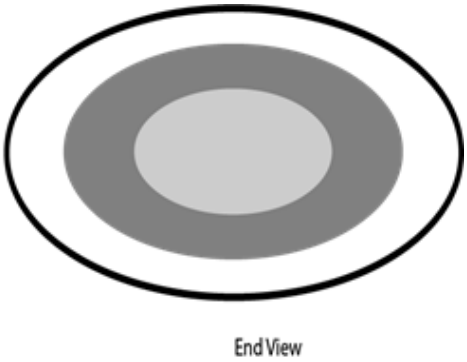
Disadvantages Of Coaxial cable:

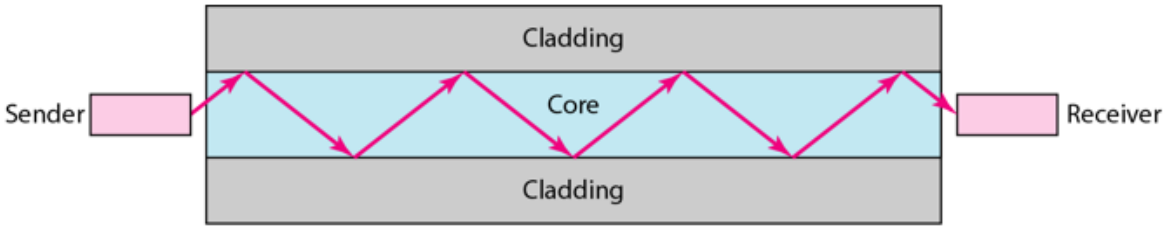
- It is more expensive as compared to twisted pair cable.
- If any fault occurs in the cable causes the failure in the entire network.

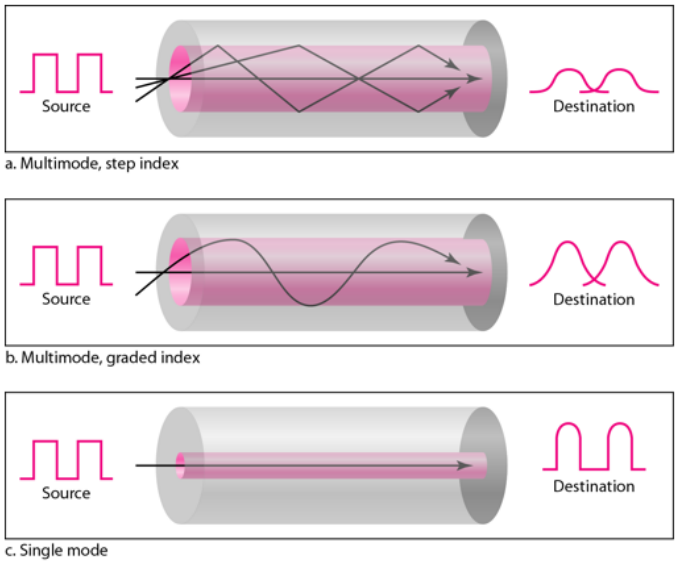
Fibre Optic

- Fibre optic cable is a cable that uses electrical signals for communication.
- Fibre optic is a cable that holds the optical fibres coated in plastic that are used to send the data by pulses of light.
- The plastic coating protects the optical fibres from heat, cold, electromagnetic interference from other types of wiring.
- Fibre optics provide faster data transmission than copper wires.







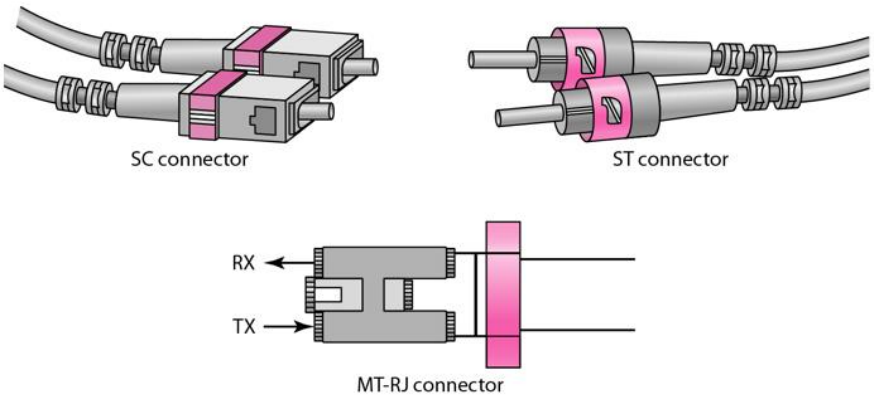


Basic elements of Fibre optic cable:

- **Core:** The optical fibre consists of a narrow strand of glass or plastic known as a core. A core is a light transmission area of the fibre. The more the area of the core, the more light will be transmitted into the fibre.
- **Cladding:** The concentric layer of glass is known as cladding. The main functionality of the cladding is to provide the lower refractive index at the core interface as to cause the reflection within the core so that the light waves are transmitted through the fibre.
- **Jacket:** The protective coating consisting of plastic is known as a jacket. The main purpose of a jacket is to preserve the fibre strength, absorb shock and extra fibre protection.

Following are the advantages of fibre optic cable over copper:

- **Greater Bandwidth:** The fibre optic cable provides more bandwidth as compared copper. Therefore, the fibre optic carries more data as compared to copper cable.
- **Faster speed:** Fibre optic cable carries the data in the form of light. This allows the fibre optic cable to carry the signals at a higher speed.
- **Longer distances:** The fibre optic cable carries the data at a longer distance as compared to copper cable.
- **Better reliability:** The fibre optic cable is more reliable than the copper cable as it is immune to any temperature changes while it can cause obstruct in the connectivity of copper cable.
- **Thinner and Sturdier:** Fibre optic cable is thinner and lighter in weight so it can withstand more pull pressure than copper cable.



9) Explain the technique used in ASK and FSK.

Amplitude Shift keying

In amplitude shift keying, the amplitude of the carrier signal is varied to create signal elements. Both frequency and phase remain constant while the amplitude changes.

Binary ASK (BASK)
Although we can have several levels (kinds) of signal elements, each with a different amplitude, ASK is normally implemented using only two levels. This is referred to as binary amplitude shift keying or *on-off keying* (OOK). The peak amplitude of one signal level is 0; the other is the same as the amplitude of the carrier frequency. gives a conceptual view of binary ASK.

Although the carrier signal is only one simple sine wave, the process of modulation produces a
nonperiodic composite signal. This signal, as was discussed in Chapter 3, has a continuous set of frequencies. As we expect, the bandwidth is proportional to the signal rate (baud rate). However, there is normally another factor involved, called *d*, which depends on the modulation and filtering process. The value of *d* is between 0 and 1. This means that the bandwidth can be expressed as shown, where 5 is the signal rate and the *B* is the bandwidth.

$$B = (1 + d) \times S$$

Frequency Shift Keying

In frequency shift keying, the frequency of the carrier signal is varied to represent data. The frequency of the modulated signal is constant for the duration of one signal element, but changes for the next signal element if the data element changes. Both peak amplitude and phase remain constant for all signal elements.

One way to think about binary FSK (or BFSK) is to consider two carrier frequencies. In Figure 5.6, we have selected two carrier frequencies, f1 and12. We use the first carrier if the data element is 0; we use the second if the data element is 1. However, note that this is an unrealistic example used only for demonstration purposes. Normally the carrier frequencies are very high, and the difference between them is very small. Again the carrier signals are only simple sine waves, but the modulation creates a non periodic composite signal with continuous frequencies. We can think of FSK as two ASK signals, each with its own carrier frequency Cil or F2*).* If the difference between the two frequencies is *2DELf,* then the required bandwidth is

$$B = (1 + d) \times S + 2\Delta f$$

10) Explain in detail about TDM and FDM.

Time-Division Multiplexing

Types of TDM

1. Synchronous TDM
2. Asynchronous TDM

Synchronous TDM (STDM)

1. In synchronous TDM, each device is given same **time slot** to transmit the data over the link, irrespective of the fact that the device has any data to transmit or not. Hence the name Synchronous TDM. Synchronous TDM requires that the total speed of various input lines should not exceed the capacity of path.

2. Each device places its data onto the link when its **time slot** arrives *i.e.* each device is given the possession of line turn by turn.

3. If any device does not have data to send then its time slot remains empty.

4. The various time slots are organized into **frames** and each frame consists of one or more time slots dedicated to each sending device.

5. If there are *n* sending devices, there will be *n* slots in frame *i.e.* one slot for each device.

6. As show in fig, there are 3 input devices, so there are 3 slots in each frame.

Asynchronous TDM

1. It is also known as statistical time division multiplexing.

2. Asynchronous TDM is called so because is this type of multiplexing, time slots are not fixed *i.e.* the slots are flexible.

3. Here, the total speed of input lines can be greater than the capacity of the path.

4. In synchronous TDM, if we have *n* input lines then there are *n* slots in one frame. But in asynchronous it is not so.

5. In asynchronous TDM, if we have *n* input lines then the frame contains not more than *m* slots, with *m* less than *n (m < n).*

6. In asynchronous TDM, the number of time slots in a frame is based on a statistical analysis of number of input lines.

7. In this system slots are not predefined, the slots are allocated to any of the device that has data to send.

8. The multiplexer scans the various input lines, accepts the data from the lines that have data to send, fills the frame and then sends the frame across the link.

9. If there are not enough data to fill all the slots in a frame, then the frames are transmitted partially filled.

10. Asynchronous Time Division Multiplexing is depicted in fig. Here we have five input lines and three slots per frame.

11. In Case 1, only three out of five input lines place data onto the link *i.e.* number of input lines and number of slots per frame are same.

12. In Case 2, four out of five input lines are active. Here number of input line is one more than the number of slots per frame.

13. In Case 3, all five input lines are active.

In all these cases, multiplexer scans the various lines in order and fills the frames and transmits them across the channel.

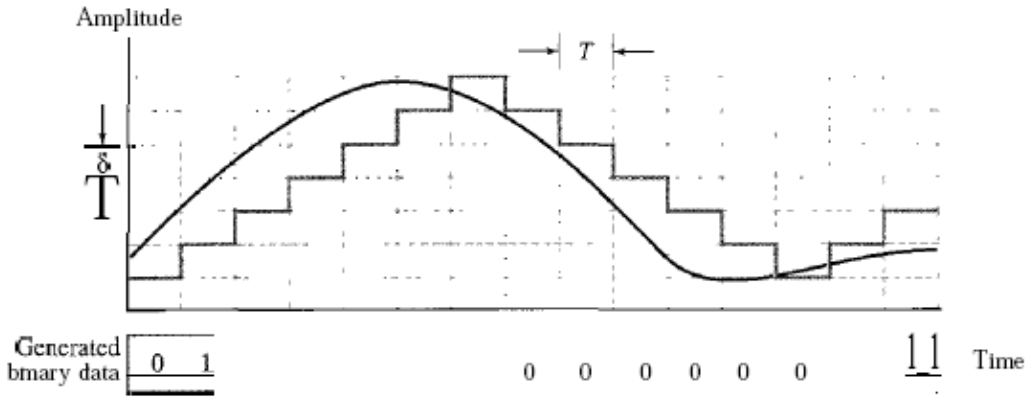
The distribution of various slots in the frames is not symmetrical. In case 2, device 1 occupies first slot in first frame, second slot in second frame and third slot in third frame.

11) Explain Pulse code Modulation and delta modulation.

Pulse Code Modulation (PCM)

The most common technique to change an analog signal to digital data (digitization) is called pulse code modulation (PCM)
1. The analog signal is sampled.
2. The sampled signal is quantized.
3. The quantized values are encoded as streams of bits.
The transmitter section of a Pulse Code Modulator circuit consists of Sampling, Quantizing and Encoding, which are performed in the analog-to-digital converter section. The low pass filter prior to sampling prevents aliasing of the message signal.

Delta Modulation (DM)



PCM is a very complex technique. Other techniques have been developed to reduce the complexity of PCM. The simplest is *delta modulation.* PCM finds the value of the signal amplitude for each sample; DM finds the change from the previous sample. Note that there are no code words here; bits are sent one after another.