# DATA COMMUNICATION & FIBRE OPTICS

## (EXAM ORIENTED)

CONTACT : 7025190151

# MODULE 1:

### 1 .EXPLAIN Transmission Modes ?

- The way in which data is transmitted from one device to another device is known as **transmission mode**.
- The transmission mode is also known as the communication mode.
- Each communication channel has a direction associated with it, and transmission media provide the direction. Therefore, the transmission mode is also known as a directional mode.
- The transmission mode is defined in the physical layer.

The Transmission mode is divided into three categories:

- Simplex mode
- Half-duplex mode
- Full-duplex mode

### Simplex mode :

- In Simplex mode, the communication is unidirectional, i.e., the data flow in one direction.
- A device can only send the data but cannot receive it or it can receive the data but cannot send the data.
- This transmission mode is not very popular as mainly communications require the two-way exchange of data. The simplex mode is used in the business field as in sales that do not require any corresponding reply.

- The radio station is a simplex channel as it transmits the signal to the listeners but never allows them to transmit back.
- Keyboard and Monitor are the examples of the simplex mode as a keyboard can only accept the data from the user and monitor can only be used to display the data on the screen.
- The main advantage of the simplex mode is that the full capacity of the communication channel can be utilized during transmission.

## Half-Duplex mode :

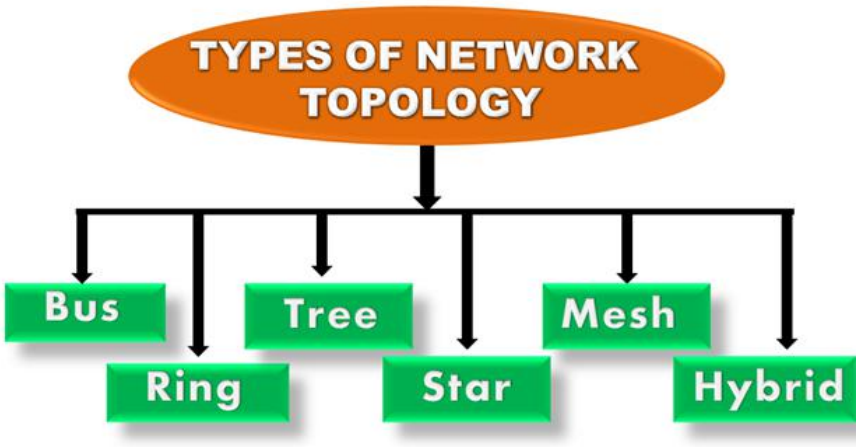
- In a Half-duplex channel, direction can be reversed, i.e., the station can transmit and receive the data as well.
- Messages flow in both the directions, but not at the same time.
- The entire bandwidth of the communication channel is utilized in one direction at a time.
- In half-duplex mode, it is possible to perform the error detection, and if any error occurs, then the receiver requests the sender to retransmit the data.
- A **Walkie-talkie** is an example of the Half-duplex mode. In Walkie-talkie, one party speaks, and another party listens. After a pause, the other speaks and first party listens. Speaking simultaneously will create the distorted sound which cannot be understood.

## Full-duplex mode :

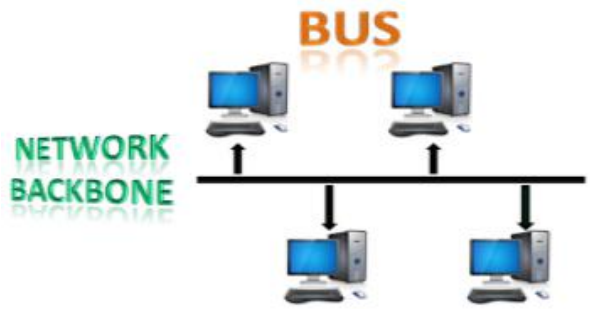
- In Full duplex mode, the communication is bi-directional, i.e., the data flow in both the directions.
- Both the stations can send and receive the message simultaneously.
- Full-duplex mode has two simplex channels. One channel has traffic moving in one direction, and another channel has traffic flowing in the opposite direction.
- The Full-duplex mode is the fastest mode of communication between devices.

- The most common example of the full-duplex mode is a telephone network. When two people are communicating with each other by a telephone line, both can talk and listen at the same time.

## 2 . EXPLAIN NETWORK TOPOLOGIES WITH ADVANTAGES & DISADVANATGES ? - ESSAY QSTN (N.B)




## Bus Topology :




- The bus topology is designed in such a way that all the stations are connected through a single cable known as a backbone cable.
- Each node is either connected to the backbone cable by drop cable or directly connected to the backbone cable.
- When a node wants to send a message over the network, it puts a message over the network. All the stations

available in the network will receive the message whether it has been addressed or not.

- The backbone cable is considered as a "single lane" through which the message is broadcast to all the stations.

## Advantages of Bus topology:

- **Low-cost cable:** In bus topology, nodes are directly connected to the cable without passing through a hub. Therefore, the initial cost of installation is low.
- **Moderate data speeds:** Coaxial or twisted pair cables are mainly used in bus-based networks that support upto 10 Mbps.
- **Familiar technology:** Bus topology is a familiar technology as the installation and troubleshooting techniques are well known, and hardware components are easily available.
- **Limited failure:** A failure in one node will not have any effect on other nodes.

## Disadvantages of Bus topology:

- **Extensive cabling:** A bus topology is quite simpler, but still it requires a lot of cabling.
- **Difficult troubleshooting:** It requires specialized test equipment to determine the cable faults. If any fault occurs in the cable, then it would disrupt the communication for all the nodes.
- **Signal interference:** If two nodes send the messages simultaneously, then the signals of both the nodes collide with each other.
- **Reconfiguration difficult:** Adding new devices to the network would slow down the network.

- **Attenuation:** Attenuation is a loss of signal leads to communication issues. Repeaters are used to regenerate the signal.

## Ring Topology :


- Ring topology is like a bus topology, but with connected ends.
- The node that receives the message from the previous computer will retransmit to the next node.
- The data flows in one direction, i.e., it is unidirectional.
- The data flows in a single loop continuously known as an endless loop.
- It has no terminated ends, i.e., each node is connected to other node and having no termination point.
- The data in a ring topology flow in a clockwise direction.
- The most common access method of the ring topology is token passing.
    - Token passing: It is a network access method in which token is passed from one node to another node.

- Token: It is a frame that circulates around the network.

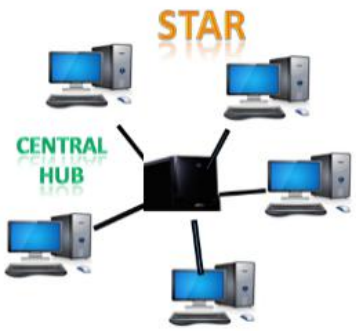
### Advantages of Ring topology:

- **Network Management:** Faulty devices can be removed from the network without bringing the network down.
- **Product availability:** Many hardware and software tools for network operation and monitoring are available.
- **Cost:** Twisted pair cabling is inexpensive and easily available. Therefore, the installation cost is very low.
- **Reliable:** It is a more reliable network because the communication system is not dependent on the single host computer.

### Disadvantages of Ring topology:

- **Difficult troubleshooting:** It requires specialized test equipment to determine the cable faults. If any fault occurs in the cable, then it would disrupt the communication for all the nodes.
- **Failure:** The breakdown in one station leads to the failure of the overall network.
- **Reconfiguration difficult:** Adding new devices to the network would slow down the network.
- **Delay:** Communication delay is directly proportional to the number of nodes. Adding new devices increases the communication delay.

## Star Topology :




- Star topology is an arrangement of the network in which every node is connected to the central hub, switch or a central computer.
- The central computer is known as a **server**, and the peripheral devices attached to the server are known as **clients**.
- Coaxial cable or RJ-45 cables are used to connect the computers.
- Hubs or Switches are mainly used as connection devices in a **physical star topology**.
- Star topology is the most popular topology in network implementation.

## Advantages of Star topology :

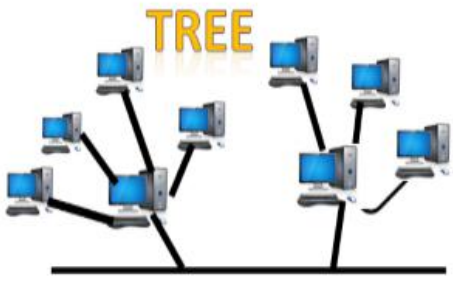
- **Efficient troubleshooting:** Troubleshooting is quite efficient in a star topology as compared to bus topology. In a bus topology, the manager has to inspect the kilometers of cable. In a star topology, all the stations are connected to the centralized network. Therefore, the network administrator has to go to the single station to troubleshoot the problem.
- **Network control:** Complex network control features can be easily implemented in the star topology. Any changes made in the star topology are automatically accommodated.

- **Limited failure:** As each station is connected to the central hub with its own cable, therefore failure in one cable will not affect the entire network.
- **Familiar technology:** Star topology is a familiar technology as its tools are cost-effective.
- **Easily expandable:** It is easily expandable as new stations can be added to the open ports on the hub.
- **Cost effective:** Star topology networks are cost-effective as it uses inexpensive coaxial cable.
- **High data speeds:** It supports a bandwidth of approx 100Mbps. Ethernet 100BaseT is one of the most popular Star topology networks.

### Disadvantages of Star topology :

- **A Central point of failure:** If the central hub or switch goes down, then all the connected nodes will not be able to communicate with each other.
- **Cable:** Sometimes cable routing becomes difficult when a significant amount of routing is required.

## Tree topology :




- Tree topology combines the characteristics of bus topology and star topology.
- A tree topology is a type of structure in which all the computers are connected with each other in hierarchical fashion.

- The top-most node in tree topology is known as a root node, and all other nodes are the descendants of the root node.
- There is only one path exists between two nodes for the data transmission. Thus, it forms a parent-child hierarchy.

## Advantages of Tree topology

- **Support for broadband transmission:** Tree topology is mainly used to provide broadband transmission, i.e., signals are sent over long distances without being attenuated.
- **Easily expandable:** We can add the new device to the existing network. Therefore, we can say that tree topology is easily expandable.
- **Easily manageable:** In tree topology, the whole network is divided into segments known as star networks which can be easily managed and maintained.
- **Error detection:** Error detection and error correction are very easy in a tree topology.
- **Limited failure:** The breakdown in one station does not affect the entire network.
- **Point-to-point wiring:** It has point-to-point wiring for individual segments.

## Disadvantages of Tree topology

- **Difficult troubleshooting:** If any fault occurs in the node, then it becomes difficult to troubleshoot the problem.
- **High cost:** Devices required for broadband transmission are very costly.
- **Failure:** A tree topology mainly relies on main bus cable and failure in main bus cable will damage the overall network.

- **Reconfiguration difficult:** If new devices are added, then it becomes difficult to reconfigure.

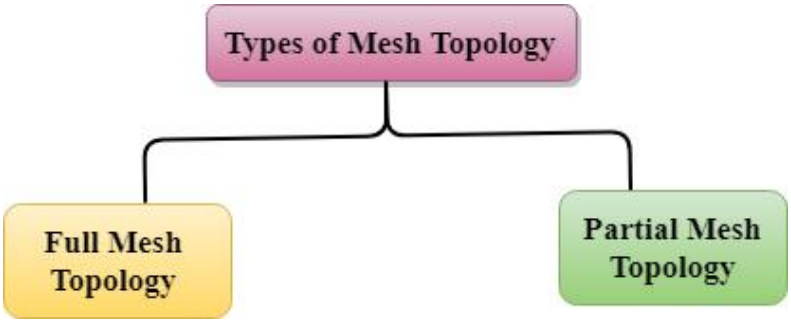
## Mesh topology :


- Mesh technology is an arrangement of the network in which computers are interconnected with each other through various redundant connections.
- There are multiple paths from one computer to another computer.
- It does not contain the switch, hub or any central computer which acts as a central point of communication.
- The Internet is an example of the mesh topology.
- Mesh topology is mainly used for WAN implementations where communication failures are a critical concern.
- Mesh topology is mainly used for wireless networks.
- Mesh topology can be formed by using the formula:
  **Number of cables = (n*(n-1))/2;**

Where n is the number of nodes that represents the network.

**Mesh topology is divided into two categories :**

- Fully connected mesh topology
- Partially connected mesh topology




- **Full Mesh Topology:** In a full mesh topology, each computer is connected to all the computers available in the network.
- **Partial Mesh Topology:** In a partial mesh topology, not all but certain computers are connected to those computers with which they communicate frequently.

### Advantages of Mesh topology :

**Reliable:** The mesh topology networks are very reliable as if any link breakdown will not affect the communication between connected computers.

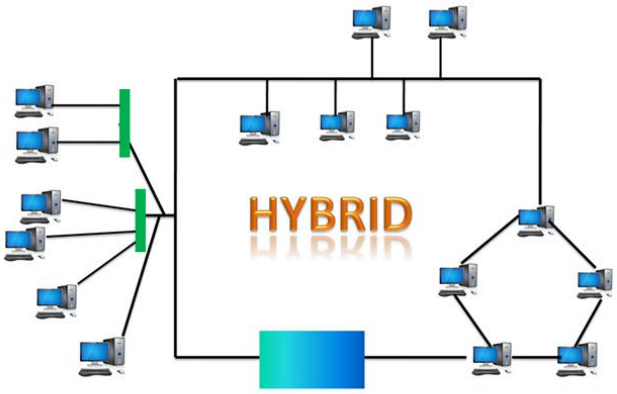
**Fast Communication:** Communication is very fast between the nodes.

**Easier Reconfiguration:** Adding new devices would not disrupt the communication between other devices.

### Disadvantages of Mesh topology :

- **Cost:** A mesh topology contains a large number of connected devices such as a router and more transmission media than other topologies.
- **Management:** Mesh topology networks are very large and very difficult to maintain and manage. If the network is not monitored carefully, then the communication link failure goes undetected.
- **Efficiency:** In this topology, redundant connections are high that reduces the efficiency of the network.

## Hybrid Topology :




- The combination of various different topologies is known as **Hybrid topology**.
- A Hybrid topology is a connection between different links and nodes to transfer the data.
- When two or more different topologies are combined together is termed as Hybrid topology and if similar topologies are connected with each other will not result in Hybrid topology. For example, if there exist a ring topology in one branch of ICICI bank and bus topology in another branch of ICICI bank, connecting these two topologies will result in Hybrid topology.

## Advantages of Hybrid Topology :

- **Reliable:** If a fault occurs in any part of the network will not affect the functioning of the rest of the network.
- **Scalable:** Size of the network can be easily expanded by adding new devices without affecting the functionality of the existing network.
- **Flexible:** This topology is very flexible as it can be designed according to the requirements of the organization.
- **Effective:** Hybrid topology is very effective as it can be designed in such a way that the strength of the network is maximized and weakness of the network is minimized.

## Disadvantages of Hybrid topology :

- **Complex design:** The major drawback of the Hybrid topology is the design of the Hybrid network. It is very difficult to design the architecture of the Hybrid network.
- **Costly Hub:** The Hubs used in the Hybrid topology are very expensive as these hubs are different from usual Hubs used in other topologies.
- **Costly infrastructure:** The infrastructure cost is very high as a hybrid network requires a lot of cabling, network devices, etc.

## 3. ENCODING & MODULATION ?

•

•

## 3.3. Encoding and Modulation

*Encoding and Modulation* are two techniques used to provide the means of mapping information or data into different waveforms such that the receiver (with the help of an appropriate demodulator and decoder) can recover the information in a reliable manner.

| Data | Signal | Approach |
|---|---|---|
| Digital | Digital | Encoding |
| Analogue | Digital | Encoding |
| Analogue | Analogue | Modulation |
| Digital | Analogue | Modulation |

Encoding and modulation technique can be divided into the following types, depending upon the types of conversion.

- ***Digital Data to Digital Signals***: In this encoding scheme, the digital data are converted into digital signals for transmission. Digital data can be mapped onto digital signals using mapping schemes like Line Coding, Block Coding, and Scrambling.
- ***Analogue Data to Digital Signals***: In this encoding scheme, the analogue data are converted into digital signals for transmission. Techniques like Pulse Code Modulation and Delta Modulation fall under this category.
- ***Analogue Data to Analogue Signals***: In this modulation scheme, the analogue data will be converted into analogue signals for transmission. The modulation techniques such as Amplitude Modulation, Frequency Modulation and Phase Modulation of analogue signals, fall under this category.
- ***Digital Data to Analogue Signals***: In this modulation scheme, the digital data are converted into analogue signals for transmission. The modulation techniques such as Amplitude Shift Keying, Frequency Shift Keying, Phase Shift Keying, etc., fall under this category.

# 4 . Analog to Digital Conversion ( TECHNIQUES EXPLAIN) - (PCM & DELTA MODULATION)

**Digital Signal:** A digital signal is a signal that represents data as a sequence of discrete values; at any given time it can only take on one of a finite number of values.

**Analog Signal:** An analog signal is any continuous signal for which the time varying feature of the signal is a representation of some other time varying quantity i.e., analogous to another time varying signal.

The following techniques can be used for Analog to Digital Conversion:

## 1. PULSE CODE MODULATION:

The most common technique to change an analog signal to digital data is called pulse code modulation (PCM). A PCM encoder has the following three processes:

1. Sampling
2. Quantization
3. Encoding

**Low pass filter :**
The low pass filter eliminates the high frequency components present in the input analog signal to ensure that the input signal to sampler is free from the unwanted frequency components.This is done to avoid aliasing of the message signal.

1. **Sampling –** The first step in PCM is sampling. Sampling is a process of measuring the amplitude of a continuous-time signal at discrete instants, converting the continuous signal into a discrete signal. There are three sampling methods:

**(i) Ideal Sampling:** In ideal Sampling also known as Instantaneous sampling pulses from the analog signal are sampled. This is an ideal sampling method and cannot be easily implemented.

**(ii) Natural Sampling:** Natural Sampling is a practical method of sampling in which pulse have finite width equal to T.The result is a sequence of samples that retain the shape of the analog signal.

**(iii) Flat-Top sampling:** In comparison to natural sampling flat top sampling can be easily obtained. In this sampling technique, the top of the samples remains constant by using a circuit. This is the most common sampling method used.

**2 . Quantization –** The result of sampling is a series of pulses with amplitude values between the maximum and minimum amplitudes of the signal. The set of amplitudes can be infinite with non-integral values between two limits.

The following are the steps in Quantization:

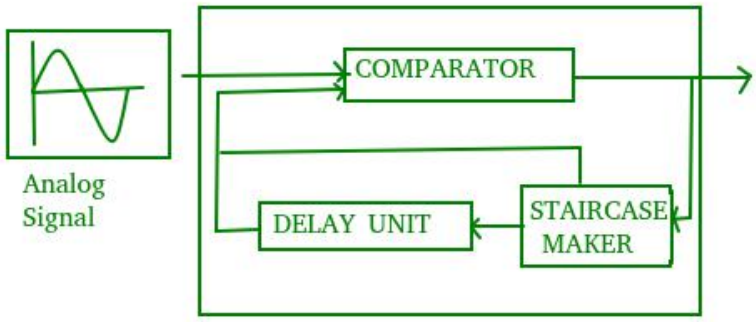
1 . We assume that the signal has amplitudes between Vmax and Vmin
2 . We divide it into L zones each of height d where,
d= (Vmax- Vmin)/ L
3 . The value at the top of each sample in the graph shows the actual amplitude.
4 . The normalized pulse amplitude modulation(PAM) value is calculated using the formula amplitude/d.
5 . After this we calculate the quantized value which the process selects from the middle of each zone.
6 . The Quantized error is given by the difference between quantised value and normalised PAM value.
7 . The Quantization code for each sample based on quantization levels at the left of the graph.

**3 . Encoding –** The digitization of the analog signal is done by the encoder. After each sample is quantized and the number of bits per sample is decided, each sample can be changed to an n bit code. Encoding also minimizes the bandwidth used.

## 2 . DELTA MODULATION :

Since PCM is a very complex technique, other techniques have been developed to reduce the complexity of PCM. The simplest is delta Modulation. Delta Modulation finds the change from the previous value.

**Modulator** – The modulator is used at the sender site to create a stream of bits from an analog signal. The process records a small positive change called delta. If the delta is positive, the process records a 1 else the process records a 0. The modulator builds a second signal that resembles a staircase. The input signal is then compared with this gradually made staircase signal.




We have the following rules for output:

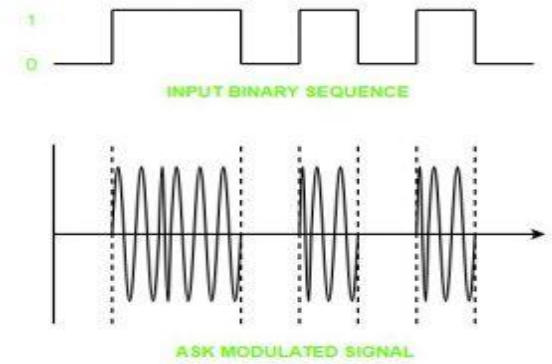
1 . If the input analog signal is higher than the last value of the staircase signal, increase delta by 1, and the bit in the digital data is 1.
2 . If the input analog signal is lower than the last value of the staircase signal, decrease delta by 1, and the bit in the digital data is 0.

## 5 . Digital to Analog Conversion ? ( TECHNIQUES EXPLAIN) - (ASK,FSK,PSK)

**1. Amplitude Shift keying** – Amplitude Shift Keying is a technique in which carrier signal is analog and data to be

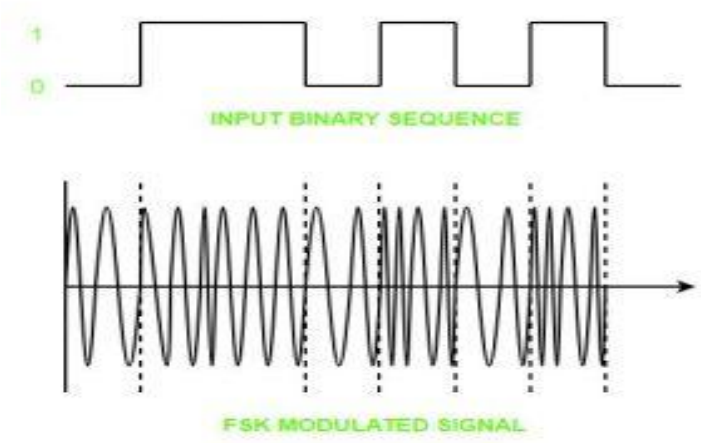
modulated is digital. The amplitude of analog carrier signal is modified to reflect binary data.

The binary signal when modulated gives a zero value when the binary data represents 0 while gives the carrier output when data is 1. The frequency and phase of the carrier signal remain constant.



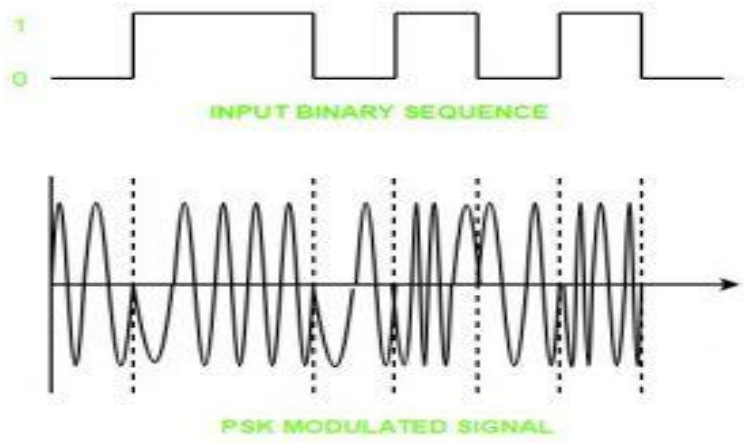

**2. Frequency Shift keying –** In this modulation the frequency of analog carrier signal is modified to reflect binary data.

The output of a frequency shift keying modulated wave is high in frequency for a binary high input and is low in frequency for a binary low input. The amplitude and phase of the carrier signal remain constant.




**3. Phase Shift keying –** In this modulation the phase of the analog carrier signal is modified to reflect binary data.The

amplitude and frequency of the carrier signal remains constant.




It is further categorized as follows:

*** Binary Phase Shift Keying (BPSK):** BPSK also known as phase reversal keying or 2PSK is the simplest form of phase shift keying. The Phase of the carrier wave is changed according to the two binary inputs. In Binary Phase shift keying, difference of 180 phase shift is used between binary 1 and binary 0. This is regarded as the most robust digital modulation technique and is used for long distance wireless communication.

*** Quadrature phase shift keying:** This technique is used to increase the bit rate i.e we can code two bits onto one single element. It uses four phases to encode two bits per symbol. QPSK uses phase shifts of multiples of 90 degrees.
It has double data rate carrying capacity compare to BPSK as two bits are mapped on each constellation points.

## 5 . Analog to Analog Conversion ? (TECHNIQUES EXPLAIN) - (AM,FM,PM)

Analog-to-analog conversion, or modulation, is the representation of analog information by an analog signal. It is

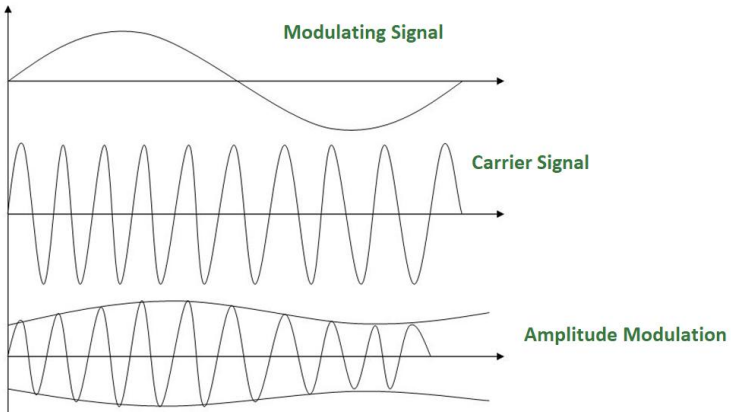
a process by virtue of which a characteristic of carrier wave is varied according to the instantaneous amplitude of the modulating signal. This modulation is generally needed when a **bandpass channel** is required. Bandpass is a range of frequencies which are transmitted through a bandpass filter which is a filter allowing specific frequencies to pass preventing signals at unwanted frequencies.

Analog to Analog conversion can be done in three ways:

1. Amplitude Modulation
2. Frequency Modulation
3. 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. The figure below shows the concept of amplitude modulation:




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.

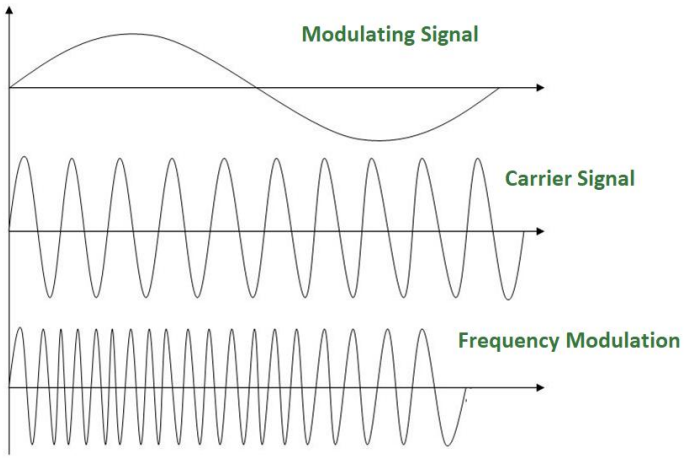
**AM bandwidth:**

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**

## 2. FREQUENCY MODULATION :

The modulation in which the frequency of the carrier wave is varied according to the instantaneous amplitude of the modulating signal keeping phase and amplitude as constant. The figure below shows the concept of frequency modulation:




FM is normally implemented by using a voltage-controlled oscillator as with FSK. The frequency of the oscillator changes according to the input voltage which is the amplitude of the modulating signal.

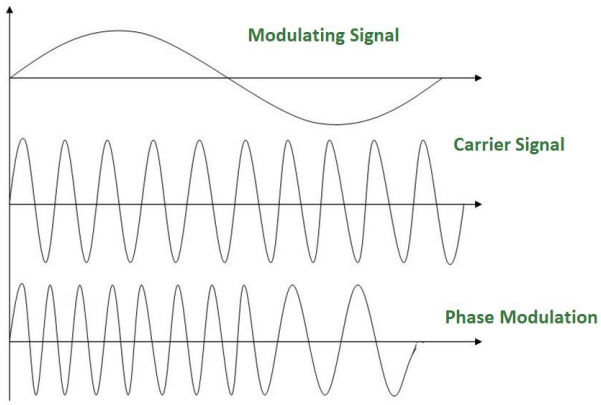
### FM bandwidth:

* The bandwidth of a frequency modulated signal varies with both deviation and modulating frequency.
If modulating frequency (Mf) 0.5, wide band Fm signal.
* For a narrow band Fm signal, bandwidth required is twice the maximum frequency of the modulation, however for a wide band Fm signal the required bandwidth can be very much larger, with detectable sidebands spreading out over large amounts of the frequency spectrum.

## 3. PHASE MODULATION:

The modulation in which the phase of the carrier wave is varied according to the instantaneous amplitude of the modulating signal keeping amplitude and frequency as

constant. The figure below shows the concept of frequency modulation:




Phase modulation is practically similar to Frequency Modulation, but in Phase modulation frequency of the carrier signal is not increased. It is normally implemented by using a voltage-controlled oscillator along with a derivative. The frequency of the oscillator changes according to the derivative of the input voltage which is the amplitude of the modulating signal.

**PM bandwidth:**

* For small amplitude signals, PM is similar to amplitude modulation (AM) and exhibits its unfortunate doubling of baseband bandwidth and poor efficiency.
* For a single large sinusoidal signal, PM is similar to FM, and its bandwidth is approximately, **2 (h+1) Fm** where h= modulation index.

Thus, Modulation allows us to send a signal over a bandpass frequency range. If every signal gets its own frequency range, then we can transmit multiple signals simultaneously over a single channel, all using different frequency ranges.

## 6 . DCE VS DTE COMPARISON - 5 MARKS

## 1. Data Terminal Equipment (DTE) :

It includes any unit that functions either as a source of or as a destination for binary digital data. At physical layer, it can be a terminal, microcomputer, computer, printer, fax, machine or any other device that generates or consumes digital data. DTEs do not often communicate information but need an intermediary to be able to communicate.

## 2. Data Circuit Terminating Equipment (DCE) :

It includes any functional unit that transmit or receives data in form of an analog or digital signal through a network. At physical layer, a DCE takes data generated by a DTE, converts them to an appropriate signal, and then introduces signal onto telecommunication link.

Commonly used DCEs at this layer include modems. In any network, a DTE generates digital data and passes them to a DCE. DCE converts that data to a form acceptable to transmission medium and sends converted signal to another DCE on network. The second DCE takes signal off line, converts it to a form usuable by its DTE, and delivers it.

## Difference between DTE and DCE :

| SR.NO | DTE | DCE |
|---|---|---|
| 1 | DTE stands for Data Termination Equipment. | DCE stands for Data Communication Equipment. |
| 2 | It is a device that is an information source or an information sink. | It is a device used as an interface between a DTE. |
| 3 | DTE is concerned with source or destination of data. | DCE is concerned with communications aspect of data. |

| SR.NO | DTE | DCE |
|---|---|---|
| 4 | It produces data and transfers them to a DCE, with essential control characters. | It converts signals to a format appropriate to transmission medium and introduces it onto network line. |
| 5 | It is connected through help of a DCE network. | DCE network acts as a medium for two DTE networks. |
| 6 | Examples of DTE include computers, printers and routers, etc. | Examples of DCE include modem, ISDN adaptors, satellites and network interface cards, etc. |

## 7 . EXPLAIN TRANSMISSION MEDIUM ? - ESSAY QSTN (N.B)

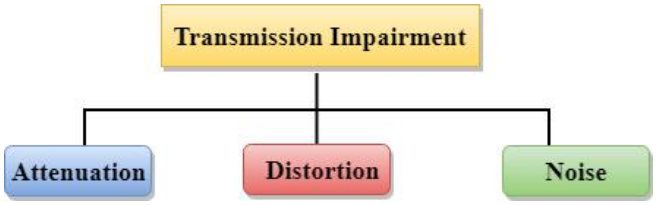
- Transmission media is a communication channel that carries the information from the sender to the receiver. Data is transmitted through the electromagnetic signals.
- The main functionality of the transmission media is to carry the information in the form of bits through **LAN**(Local Area Network).
- It is a physical path between transmitter and receiver in data communication.
- In a copper-based network, the bits in the form of electrical signals.
- In a fibre based network, the bits in the form of light pulses.

**Some factors need to be considered for designing the transmission media:**

- **Bandwidth:** All the factors are remaining constant, the greater the bandwidth of a medium, the higher the data transmission rate of a signal.

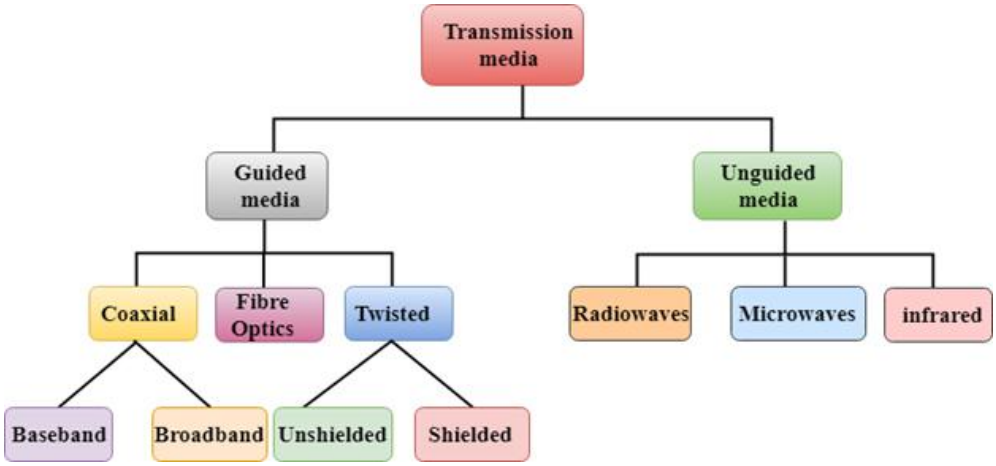
- **Transmission impairment:** When the received signal is not identical to the transmitted one due to the transmission impairment. The quality of the signals will get destroyed due to transmission impairment.
- **Interference:** An interference is defined as the process of disrupting a signal when it travels over a communication medium on the addition of some unwanted signal.

## Causes Of Transmission Impairment:




- **Attenuation:** Attenuation means the loss of energy, i.e., the strength of the signal decreases with increasing the distance which causes the loss of energy.
- **Distortion:** Distortion occurs when there is a change in the shape of the signal. This type of distortion is examined from different signals having different frequencies. Each frequency component has its own propagation speed, so they reach at a different time which leads to the delay distortion.
- **Noise:** When data is travelled over a transmission medium, some unwanted signal is added to it which creates the noise.

## Classification Of Transmission Media:




/

A comparison of the guided and unguided media is given below:

| Guided Media | Unguided Media |
|---|---|
| The signal energy propagates within the guided media | The signal energy propagates through air |
| Guided media is mainly suited for point-to-point communication | Unguided media is mainly used for broadcasting purpose |
| The signal propagates in guided media in the form of voltage, current or photons | The signal propagates in unguided media in the form of electromagnetic waves |

## *Guided Media :

It is defined as the physical medium through which the signals are transmitted. It is also known as Bounded media.

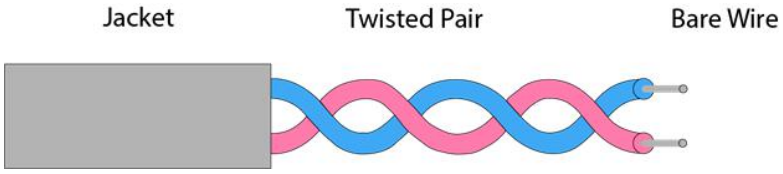
Types Of Guided media :

## 1 . Twisted pair :

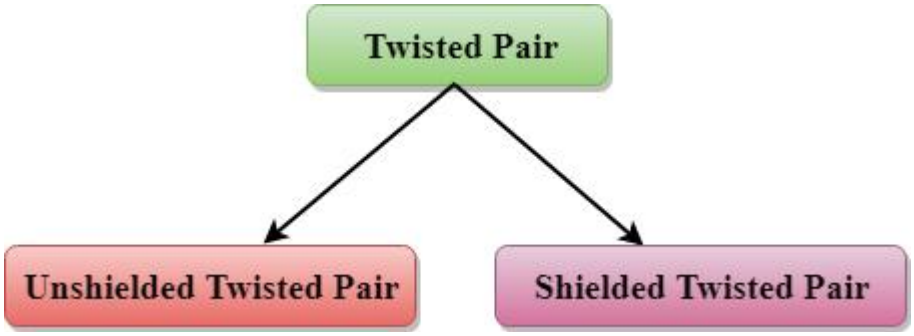
Twisted pair is a physical media made up of a pair of cables twisted with each other. A twisted pair cable is cheap as compared to other transmission media. Installation of the twisted pair cable is easy, and it is a lightweight cable. The frequency range for twisted pair cable is from 0 to 3.5KHz.

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.

### - Shielded Twisted Pair :

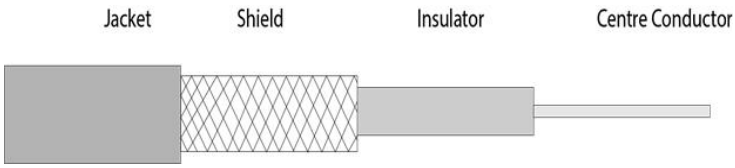
A shielded twisted pair is a cable that contains the mesh surrounding the wire that allows the higher transmission rate.

**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.

## 2 . 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).




**Coaxial cable is of two types:**

1. **Baseband transmission:** It is defined as the process of transmitting a single signal at high speed.
2. **Broadband transmission:** It is defined as the process of transmitting multiple signals simultaneously.

**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.

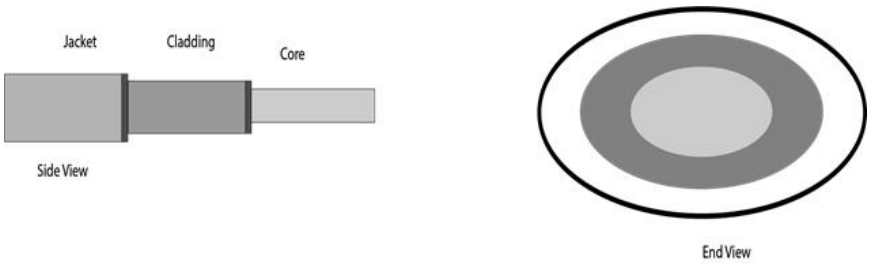
**Disadvantages Of Coaxial cable :**

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

## 3 . 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.**

**Diagrammatic representation of fibre optic cable:**




**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.

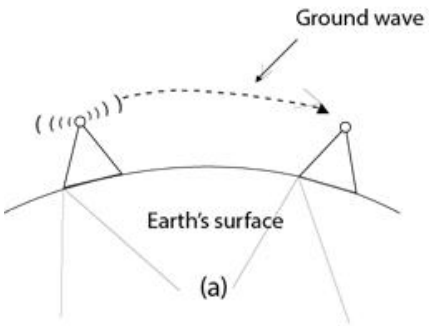
## *UnGuided Media :

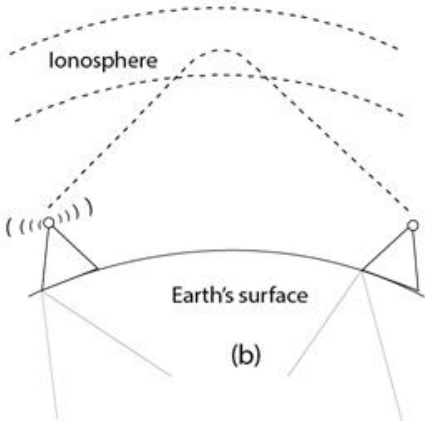
- An unguided transmission transmits the electromagnetic waves without using any physical medium. Therefore it is also known as **wireless transmission**.
- In unguided media, air is the media through which the electromagnetic energy can flow easily.

**Unguided transmission is broadly classified into three categories:**

## 1 . Radio waves :

- Radio waves are the electromagnetic waves that are transmitted in all the directions of free space.
- Radio waves are omnidirectional, i.e., the signals are propagated in all the directions.
- The range in frequencies of radio waves is from 3Khz to 1 khz.
- In the case of radio waves, the sending and receiving antenna are not aligned, i.e., the wave sent by the sending antenna can be received by any receiving antenna.
- An example of the radio wave is **FM radio**.

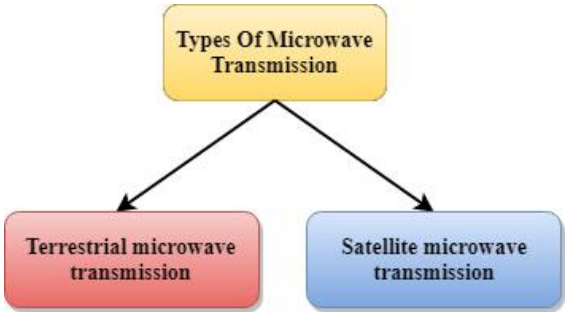



**Applications Of Radio waves:**

- **A Radio wave is useful for multicasting when there is one sender and many receivers.**
- **An FM radio, television, cordless phones are examples of a radio wave.**

## 2 . Microwaves :




### Microwaves are of two types:

- **Terrestrial microwave**
- **Satellite microwave communication.**

### Characteristics of Microwave:

- **Frequency range:** The frequency range of terrestrial microwave is from 4-6 GHz to 21-23 GHz.
- **Bandwidth:** It supports the bandwidth from 1 to 10 Mbps.
- **Short distance:** It is inexpensive for short distance.

- **Long distance:** It is expensive as it requires a higher tower for a longer distance.
- **Attenuation:** Attenuation means loss of signal. It is affected by environmental conditions and antenna size.

**Advantages Of Microwave:**

- Microwave transmission is cheaper than using cables.
- It is free from land acquisition as it does not require any land for the installation of cables.
- Microwave transmission provides an easy communication in terrains as the installation of cable in terrain is quite a difficult task.

**Disadvantages of Microwave transmission:**

- **Eavesdropping:** An eavesdropping creates insecure communication. Any malicious user can catch the signal in the air by using its own antenna.
- **Out of phase signal:** A signal can be moved out of phase by using microwave transmission.
- **Susceptible to weather condition:** A microwave transmission is susceptible to weather condition. This means that any environmental change such as rain, wind can distort the signal.
- **Bandwidth limited:** Allocation of bandwidth is limited in the case of microwave transmission.

## Satellite Microwave Communication :

- A satellite is a physical object that revolves around the earth at a known height.
- Satellite communication is more reliable nowadays as it offers more flexibility than cable and fibre optic systems.
- We can communicate with any point on the globe by using satellite communication.

## 3 . Infrared :

- An infrared transmission is a wireless technology used for communication over short ranges.
- The frequency of the infrared in the range from 300 GHz to 400 THz.
- It is used for short-range communication such as data transfer between two cell phones, TV remote operation, data transfer between a computer and cell phone resides in the same closed area.

**Characteristics Of Infrared:**

- It supports high bandwidth, and hence the data rate will be very high.
- Infrared waves cannot penetrate the walls. Therefore, the infrared communication in one room cannot be interrupted by the nearby rooms.
- An infrared communication provides better security with minimum interference.
- Infrared communication is unreliable outside the building because the sun rays will interfere with the infrared waves.

# MODULE 2

### 1 . WHAT IS MULTIPLEXING (MUXING , DEMUXING) ? EXPLAIN ? {FDM , WDM, TDM , CDM} - (N.B)

**What is Multiplexing?**

Multiplexing is a technique used to combine and send the multiple data streams over a single medium. The process of combining the data streams is known as multiplexing and hardware used for multiplexing is known as a multiplexer.

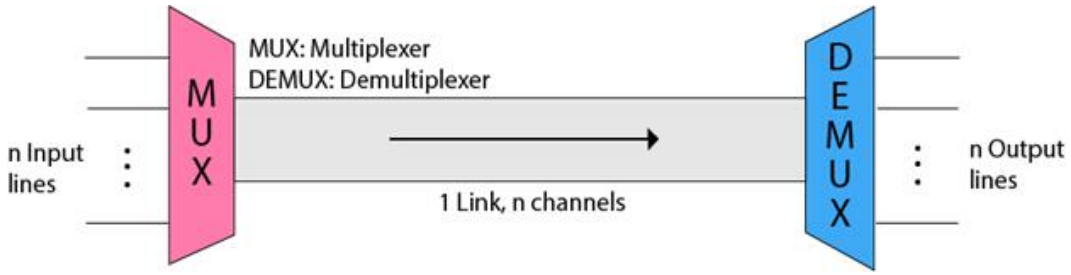
Multiplexing is achieved by using a device called Multiplexer (**MUX**) that combines n input lines to generate a single output line. Multiplexing follows many-to-one, i.e., n input lines and one output line.

Demultiplexing is achieved by using a device called Demultiplexer (**DEMUX**) available at the receiving end. DEMUX separates a signal into its component signals (one input and n outputs). Therefore, we can say that demultiplexing follows the one-to-many approach.

## Why Multiplexing?

- The transmission medium is used to send the signal from sender to receiver. The medium can only have one signal at a time.
- If there are multiple signals to share one medium, then the medium must be divided in such a way that each signal is given some portion of the available bandwidth. For example: If there are 10 signals and bandwidth of medium is100 units, then the 10 unit is shared by each signal.
- When multiple signals share the common medium, there is a possibility of collision. Multiplexing concept is used to avoid such collision.
- Transmission services are very expensive.

## Concept of Multiplexing :




- **The 'n' input lines are transmitted through a multiplexer and multiplexer combines the signals to form a composite signal.**

- **The composite signal is passed through a Demultiplexer and demultiplexer separates a signal to component signals and transfers them to their respective destinations.**

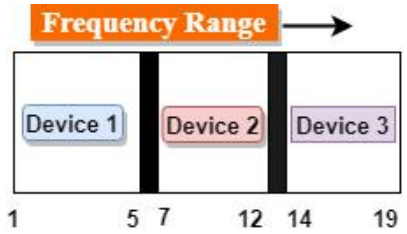
### Advantages of Multiplexing:

- **More than one signal can be sent over a single medium.**
- **The bandwidth of a medium can be utilized effectively.**

### Multiplexing Techniques:

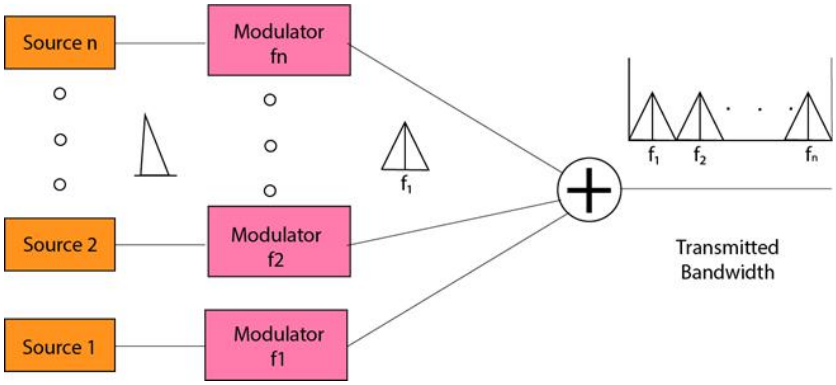
## 1 . Frequency-division Multiplexing (FDM) :

- It is an analog technique.
- **Frequency Division Multiplexing** is a technique in which the available bandwidth of a single transmission medium is subdivided into several channels.




- In the above diagram, a single transmission medium is subdivided into several frequency channels, and each frequency channel is given to different devices. Device 1 has a frequency channel of range from 1 to 5.
- The input signals are translated into frequency bands by using modulation techniques, and they are combined by a multiplexer to form a composite signal.
- The main aim of the FDM is to subdivide the available bandwidth into different frequency channels and allocate them to different devices.
- Using the modulation technique, the input signals are transmitted into frequency bands and then combined to form a composite signal.

- The carriers which are used for modulating the signals are known as **sub-carriers**. They are represented as f1,f2..fn.
- **FDM** is mainly used in radio broadcasts and TV networks.




**Advantages Of FDM:**

- FDM is used for analog signals.
- FDM process is very simple and easy modulation.
- A Large number of signals can be sent through an FDM simultaneously.
- It does not require any synchronization between sender and receiver.

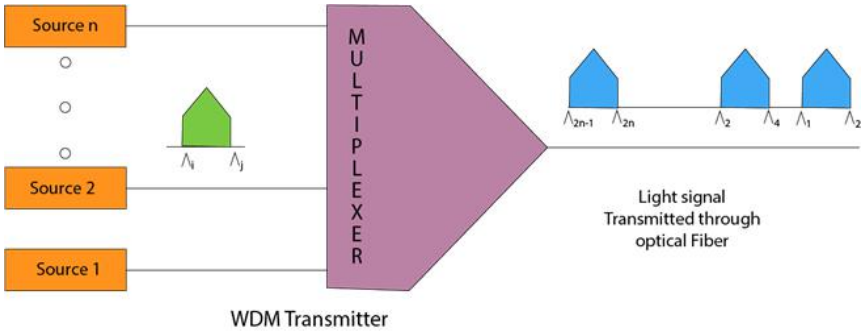
**Disadvantages Of FDM:**

- FDM technique is used only when low-speed channels are required.
- It suffers the problem of crosstalk.
- A Large number of modulators are required.
- It requires a high bandwidth channel.

**Applications Of FDM:**

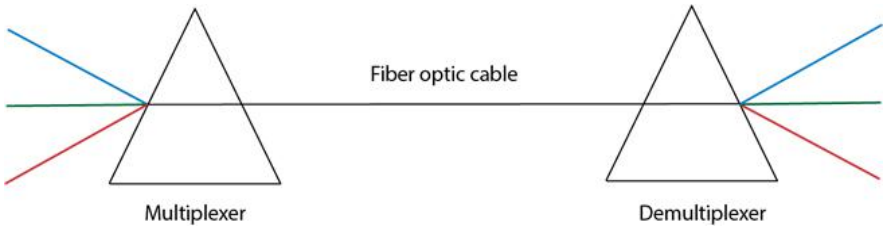
- FDM is commonly used in TV networks.
- It is used in FM and AM broadcasting. Each FM radio station has different frequencies, and they are multiplexed to form a composite signal. The multiplexed signal is transmitted in the air.

# 2 . Wavelength Division Multiplexing (WDM) :




WDM Transmitter

- Wavelength Division Multiplexing is same as FDM except that the optical signals are transmitted through the fibre optic cable.
- WDM is used on fibre optics to increase the capacity of a single fibre.
- It is used to utilize the high data rate capability of fibre optic cable.
- It is an analog multiplexing technique.
- Optical signals from different source are combined to form a wider band of light with the help of multiplexer.
- At the receiving end, demultiplexer separates the signals to transmit them to their respective destinations.
- Multiplexing and Demultiplexing can be achieved by using a prism.
- Prism can perform a role of multiplexer by combining the various optical signals to form a composite signal, and the composite signal is transmitted through a fibre optical cable.
- Prism also performs a reverse operation, i.e., demultiplexing the signal.




# 3 . Time Division Multiplexing :

- It is a digital technique.

- In Frequency Division Multiplexing Technique, all signals operate at the same time with different frequency, but in case of Time Division Multiplexing technique, all signals operate at the same frequency with different time.
- In **Time Division Multiplexing technique**, the total time available in the channel is distributed among different users. Therefore, each user is allocated with different time interval known as a Time slot at which data is to be transmitted by the sender.
- A user takes control of the channel for a fixed amount of time.
- In Time Division Multiplexing technique, data is not transmitted simultaneously rather the data is transmitted one-by-one.
- In TDM, the signal is transmitted in the form of frames. Frames contain a cycle of time slots in which each frame contains one or more slots dedicated to each user.
- It can be used to multiplex both digital and analog signals but mainly used to multiplex digital signals.

**There are two types of TDM:**

- Synchronous TDM
- Asynchronous TDM

Advanatges & Disadvantages :

| Advantages | Disadvantages |
|---|---|
| Frequency division multiplexing is far less flexible and adaptable than time-division multiplexing. | In time-division multiplexing, synchronization is pretty much essential. |
| The hardware for time-division multiplexing is simple and straightforward. | All TDM channels may be shut down due to slow and sluggish narrowband fading. |
| Crosstalk isn't a massive concern. | There is a lot of attention laid on organization and range planning. |
| Dynamic coordination is a unique feature of TDM. | Another downside of TDM is that it has a shorter latency than FDM. |
| Another significant benefit of TDM is that, although it is chiefly used only for digital signals, it can also be implemented for analog signals. | Address information and a buffer are essential in a Time Division Multiplexing system |

## 4 . Code Division Multiplexing :

Multiple data signals can be transmitted over a single frequency by using Code Division Multiplexing. FDM divides the frequency in smaller channels but CDM allows its users to full bandwidth and transmit signals all the time using a unique code. CDM uses orthogonal codes to spread signals.

Each station is assigned with a unique code, called chip. Signals travel with these codes independently, inside the whole bandwidth.The receiver knows in advance the chip code signal it has to receive.

## 2 . CELLULAR NETWORK - OVERVIEW //

**Cellular Network is formed of some cells, cell covers a geographical region, has a base station analogous to 802.11 AP which helps mobile users attach to network and there is an air-interface of physical and link layer protocol between mobile and base station. All these base stations are connected to *Mobile Switching Center* which connects cells to wide area net, manages call setup and handles mobility.**

**There is certain radio spectrum that is allocated to base station and to a particular region and that now needs to be shared. There are 2 techniques for sharing mobile-to-base station radio spectrum are:**

** **Combined FDMA/TDMA:**
**It divide spectrum in frequency channel and divide each channel into time slots.**
** **Code Division Multiple Access (CDMA):**
**It allows reuse of same spectrum over all cells. Net capacity improvement. Two frequency bands are used one of which is for forward channel (cell-site to subscriber) and one for reverse channel (sub to cell-site).**

## 3 . GSM FULL SECTION - ESSAY OR 5 MARKS (N.B)** (ARCHITECTURE)

# What is GSM?

GSM stands for **G**lobal **S**ystem for **M**obile Communication. It is a digital cellular technology used for transmitting mobile voice and data services. Important facts about the GSM are given below −

* The concept of GSM emerged from a cell-based mobile radio system at Bell Laboratories in the early 1970s.

* GSM is the name of a standardization group established in 1982 to create a common European mobile telephone standard.

* GSM is the most widely accepted standard in telecommunications and it is implemented globally.

* GSM is a circuit-switched system that divides each 200 kHz channel into eight 25 kHz time-slots. GSM operates on the mobile communication bands 900 MHz and 1800 MHz in most parts of the world. In the US, GSM operates in the bands 850 MHz and 1900 MHz.

* GSM owns a market share of more than 70 percent of the world's digital cellular subscribers.

* GSM makes use of narrowband Time Division Multiple Access (TDMA) technique for transmitting signals.

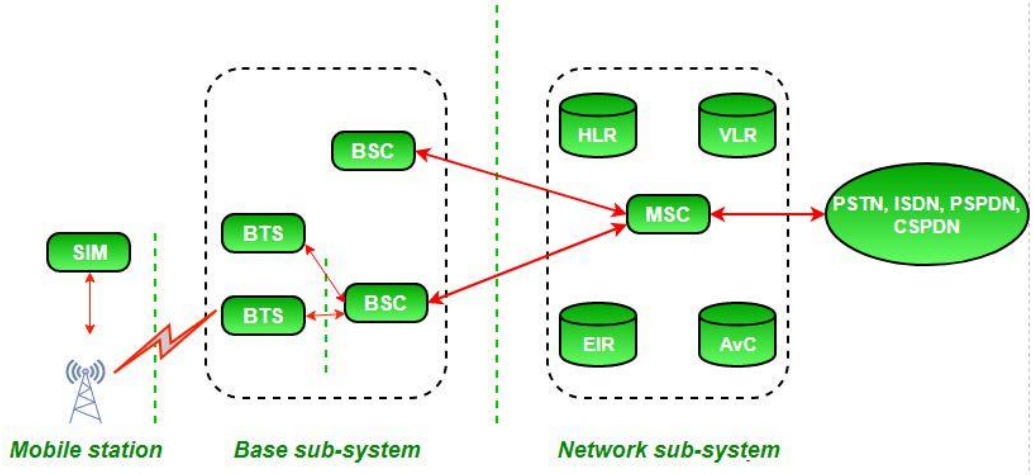
* GSM was developed using digital technology. It has an ability to carry 64 kbps to 120 Mbps of data rates.

* Presently GSM supports more than one billion mobile subscribers in more than 210 countries throughout the world.

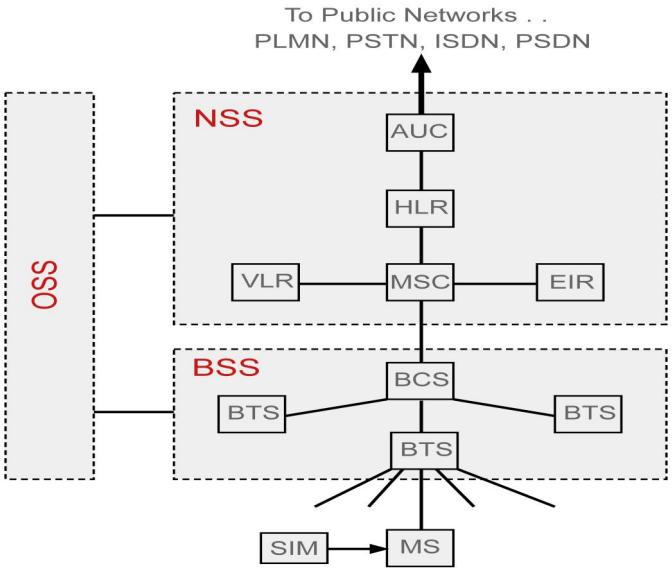
* GSM provides basic to advanced voice and data services including roaming service. Roaming is the ability to use your GSM phone number in another GSM network.

* GSM digitizes and compresses data, then sends it down through a channel with two other streams of user data, each in its own timeslot.

## GSM - Architecture :- (N.B)




OR




**A GSM network comprises of many functional units. These functions and interfaces are explained in this chapter. The GSM network can be broadly divided into −**

*** The Mobile Station (MS)**

*** The Base Station Subsystem (BSS)**

*** The Network Switching Subsystem (NSS)**

*** The Operation Support Subsystem (OSS)**

## 1 . GSM - The Mobile Station :

The MS consists of the physical equipment, such as the radio transceiver, display and digital signal processors, and the SIM card. It provides the air interface to the user in GSM networks. As such, other services are also provided, which include −

* Voice teleservices

* Data bearer services

* The features' supplementary services


The MS Functions

The MS also provides the receptor for SMS messages, enabling the user to toggle between the voice and data use. Moreover, the mobile facilitates access to voice messaging systems. The MS also provides access to the various data services available in a GSM network. These data services include −

* X.25 packet switching through a synchronous or asynchronous dial-up connection to the PAD at speeds typically at 9.6 Kbps.

* General Packet Radio Services (GPRSs) using either an X.25 or IP based data transfer method at the speed up to 115 Kbps.

* High speed, circuit switched data at speeds up to 64 Kbps.

**WHAT IS SIM?**

The SIM provides personal mobility so that the user can have access to all subscribed services irrespective of both the location of the terminal and the use of a specific terminal. You need to insert the SIM card into another GSM cellular phone to receive calls at that phone, make calls from that phone, or receive other subscribed services.

## 2 . GSM - The Base Station Subsystem (BSS) :

The BSS is composed of two parts −

* The Base Transceiver Station (BTS)

* The Base Station Controller (BSC)

The BTS and the BSC communicate across the specified Abis interface, enabling operations between components that are made by different suppliers. The radio components of a BSS may consist of four to seven or nine cells. A BSS may have one or more base stations. The BSS uses the Abis interface between the BTS and the BSC. A separate high-speed line (T1 or E1) is then connected from the BSS to the Mobile MSC.

### ** The Base Transceiver Station (BTS) :

The BTS houses the radio transceivers that define a cell and handles the radio link protocols with the MS. In a large urban area, a large number of BTSs may be deployed.

The BTS corresponds to the transceivers and antennas used in each cell of the network. A BTS is usually placed in the center of a cell. Its

transmitting power defines the size of a cell. Each BTS has between 1 and 16 transceivers, depending on the density of users in the cell. Each BTS serves as a single cell. It also includes the following functions −

* Encoding, encrypting, multiplexing, modulating, and feeding the RF signals to the antenna
* Transcoding and rate adaptation
* Time and frequency synchronizing
* Voice through full- or half-rate services
* Decoding, decrypting, and equalizing received signals
* Random access detection
* Timing advances
* Uplink channel measurements

## ** The Base Station Controller (BSC) :

The BSC manages the radio resources for one or more BTSs. It handles radio channel setup, frequency hopping, and handovers. The BSC is the connection between the mobile and the MSC. The BSC also translates the 13 Kbps voice channel used over the radio link to the standard 64 Kbps channel used by the Public Switched Telephone Network (PSDN) or ISDN.

It assigns and releases frequencies and time slots for the MS. The BSC also handles intercell handover. It controls the power transmission of the BSS and MS in its area. The function of the BSC is to allocate the necessary time slots between the BTS and the MSC. It is a switching device that handles the radio resources.

The additional functions include−

* Control of frequency hopping
* Performing traffic concentration to reduce the number of lines from the MSC
* Providing an interface to the Operations and Maintenance Center for the BSS
* Reallocation of frequencies among BTSs
* Time and frequency synchronization
* Power management

* Time-delay measurements of received signals from the MS

## 3 . GSM - The Network Switching Subsystem (NSS) :

The Network switching system (NSS), the main part of which is the Mobile Switching Center (MSC), performs the switching of calls between the mobile and other fixed or mobile network users, as well as the management of mobile services such as authentication.

The switching system includes the following functional elements −

**** Home Location Register (HLR)**

**** Mobile Services Switching Center (MSC)**

The central component of the Network Subsystem is the MSC. The MSC performs the switching of calls between the mobile and other fixed or mobile network users, as well as the management of mobile services such as registration, authentication, location updating, handovers, and call routing to a roaming subscriber. It also performs such functions as toll ticketing, network interfacing, common channel signaling, and others. Every MSC is identified by a unique ID.

**** Visitor Location Register (VLR)**

**** Authentication Center (AUC)**

**** Equipment Identity Register (EIR)**

STUDY EXPANSIONS !! OF TERMS

## 4 . GSM - The Operation Support Subsystem (OSS) :

The operations and maintenance center (OMC) is connected to all equipment in the switching system and to the BSC. The implementation of OMC is called the operation and support system (OSS).

Here are some of the OMC functions−

* Administration and commercial operation (subscription, end terminals, charging, and statistics).

* Security Management.

* Network configuration, Operation, and Performance Management.

* Maintenance Tasks.

## GSM Radio Interface:

**GSM RADIO INTERFACE Most Important Interface To increase spectral efficiency -- Large number of simultaneous calls in a given bandwidth -- Frequency Reuse -- Interference -- Use of Interference Reduction Techniques Full Compatibility between mobile stations of various Manufacturers & Networks of different vendors to help roaming**

***GSM Uplink & Downlink Frequency Bands GSM 900 Mhz DCS 1800 MHz BTSBTS UPLINK DOWNLINK**

***GSM Specifications GSM 900 Mobile to BS(UP-LINK) -890 to 915 MHz BS to Mobile (DOWN -LINK) - 935 to 960 MHz Bandwidth - 25 MHz GSM 1800 ( DCS ) Mobile to Cell(UP-LINK) -1710 to 1785 MHz Cell to Mobile (DOWN -LINK) - 1805 to 1880 MHz Bandwidth - 75 MHz RF Spectrum :**

***GSM Specifications Carrier Separation -200 kHz No. of RF Carriers -124 Access Method -TDMA/FDMA Modulation Method -GMSK Transmission Rate -270.833 Kbps Speech Coding -Full rate 13 Kbps Half rate 6.5 Kbps Duplex Distance -45 MHz**

## MODULE 3 :

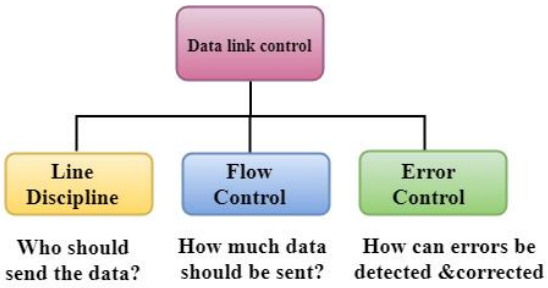
### 1 . EXPALIN DIFFERENT DATA LINK CONTROLS ? (LINE DISCIPLINE , FLOW CONTROL , ERROR CONTROL) ?

## Data Link Controls :

Data Link Control is the service provided by the Data Link Layer to provide reliable data transfer over the physical medium. For example, In the half-duplex transmission mode, one device can only transmit the data at a time. If both the devices at the end of the links transmit the data simultaneously, they will collide and leads to the loss of the information. The Data link layer provides the coordination among the devices so that no collision occurs.

**The Data link layer provides three functions:**

- Line discipline
- Flow Control
- Error Control




## 1 . Line Discipline :

- Line Discipline is a functionality of the Data link layer that provides the coordination among the link systems. It determines which device can send, and when it can send the data.

**Line Discipline can be achieved in two ways:**

- ENQ/ACK
- Poll/select

## ** END/ACK :

END/ACK stands for Enquiry/Acknowledgement is used when there is no wrong receiver available on the link and having a dedicated path between the two devices so that the device capable of receiving the transmission is the intended one.

END/ACK coordinates which device will start the transmission and whether the recipient is ready or not.

### ***Working of END/ACK :

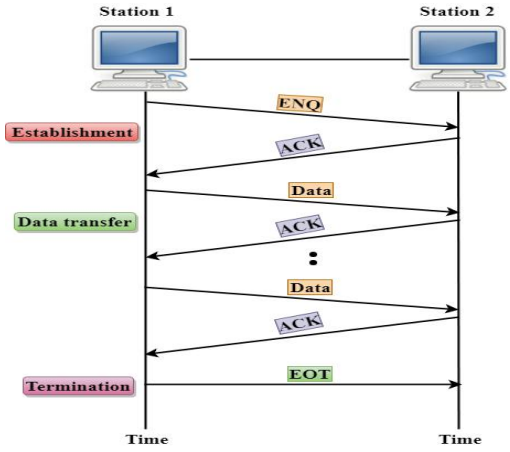
The transmitter transmits the frame called an Enquiry (ENQ) asking whether the receiver is available to receive the data or not.

The receiver responses either with the positive acknowledgement(ACK) or with the negative acknowledgement(NACK) where positive acknowledgement means that the receiver is ready to receive the

transmission and negative acknowledgement means that the receiver is unable to accept the transmission.

**Following are the responses of the receiver:**

- If the response to the ENQ is positive, the sender will transmit its data, and once all of its data has been transmitted, the device finishes its transmission with an EOT (END-of-Transmission) frame.
- If the response to the ENQ is negative, then the sender disconnects and restarts the transmission at another time.
- If the response is neither negative nor positive, the sender assumes that the ENQ frame was lost during the transmission and makes three attempts to establish a link before giving up.




## ** Poll/Select :

The Poll/Select method of line discipline works with those topologies where one device is designated as a primary station, and other devices are secondary stations.

## ***Working of Poll/Select :

- In this, the primary device and multiple secondary devices consist of a single transmission line, and all the exchanges are made through the primary device even though the destination is a secondary device.
- The primary device has control over the communication link, and the secondary device follows the instructions of the primary device.

- The primary device determines which device is allowed to use the communication channel. Therefore, we can say that it is an initiator of the session.
- If the primary device wants to receive the data from the secondary device, it asks the secondary device that they anything to send, this process is known as polling.
- If the primary device wants to send some data to the secondary device, then it tells the target secondary to get ready to receive the data, this process is known as selecting.

**Select :-**

- The select mode is used when the primary device has something to send.
- When the primary device wants to send some data, then it alerts the secondary device for the upcoming transmission by transmitting a Select (SEL) frame, one field of the frame includes the address of the intended secondary device.
- When the secondary device receives the SEL frame, it sends an acknowledgement that indicates the secondary ready status.

**Poll :-**

- The Poll mode is used when the primary device wants to receive some data from the secondary device.
- When a primary device wants to receive the data, then it asks each device whether it has anything to send.
- Firstly, the primary asks (poll) the first secondary device, if it responds with the NACK (Negative Acknowledgement) means that it has nothing to send. Now, it approaches the second secondary device, it responds with the ACK means that it has the data to send.

## 2 . Flow Control : (CAN BE ASKED FOR 5 MARKS)

- It is a set of procedures that tells the sender how much data it can transmit before the data overwhelms the receiver.

- The receiving device has limited speed and limited memory to store the data. Therefore, the receiving device must be able to inform the sending device to stop the transmission temporarily before the limits are reached.
- It requires a buffer, a block of memory for storing the information until they are processed.

**Two methods have been developed to control the flow of data:**

- Stop-and-wait (N.B)
- Sliding window

## **Stop-and-wait :

- In the Stop-and-wait method, the sender waits for an acknowledgement after every frame it sends.
- When acknowledgement is received, then only next frame is sent. The process of alternately sending and waiting of a frame continues until the sender transmits the EOT (End of transmission) frame.

**Advantage of Stop-and-wait**

The Stop-and-wait method is simple as each frame is checked and acknowledged before the next frame is sent.

**Disadvantage of Stop-and-wait**

Stop-and-wait technique is inefficient to use as each frame must travel across all the way to the receiver, and an acknowledgement travels all the way before the next frame is sent. Each frame sent and received uses the entire time needed to traverse the link.

## **Sliding Window :-

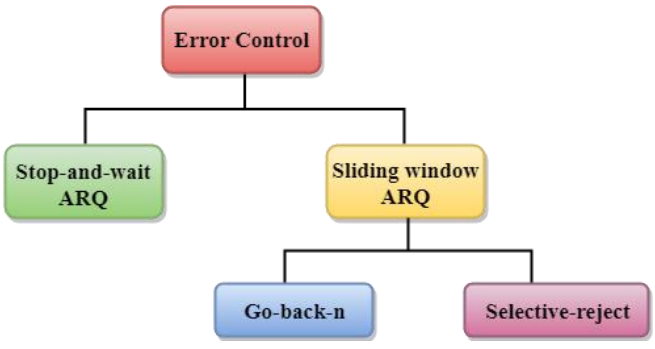
- The Sliding Window is a method of flow control in which a sender can transmit the several frames before getting an acknowledgement.

- In Sliding Window Control, multiple frames can be sent one after the another due to which capacity of the communication channel can be utilized efficiently.
- A single ACK acknowledge multiple frames.
- Sliding Window refers to imaginary boxes at both the sender and receiver end.
- The window can hold the frames at either end, and it provides the upper limit on the number of frames that can be transmitted before the acknowledgement.
- Frames can be acknowledged even when the window is not completely filled.
- The window has a specific size in which they are numbered as modulo-n means that they are numbered from 0 to n-1. For example, if n = 8, the frames are numbered from 0,1,2,3,4,5,6,7,0,1,2,3,4,5,6,7,0,1.....
- The size of the window is represented as n-1. Therefore, maximum n-1 frames can be sent before acknowledgement.
- When the receiver sends the ACK, it includes the number of the next frame that it wants to receive. For example, to acknowledge the string of frames ending with frame number 4, the receiver will send the ACK containing the number 5. When the sender sees the ACK with the number 5, it got to know that the frames from 0 through 4 have been received.

## Error Control :

**Error Control is a technique of error detection and retransmission.**

**Categories of Error Control:**



When data-frame is transmitted, there is a probability that data-frame may be lost in the transit or it is received corrupted. In both cases, the receiver does not receive the correct data-frame and sender does not know anything about any loss.In such case, both sender and receiver are equipped with some protocols which helps them to detect transit errors such as loss of data-frame. Hence, either the sender retransmits the data-frame or the receiver may request to resend the previous data-frame.

## Requirements for error control mechanism:

*** Error detection** - The sender and receiver, either both or any, must ascertain that there is some error in the transit.

*** Positive ACK** - When the receiver receives a correct frame, it should acknowledge it.

*** Negative ACK** - When the receiver receives a damaged frame or a duplicate frame, it sends a NACK back to the sender and the sender must retransmit the correct frame.

*** Retransmission:** The sender maintains a clock and sets a timeout period. If an acknowledgement of a data-frame previously transmitted does not arrive before the timeout the sender retransmits the frame, thinking that the frame or it's acknowledgement is lost in transit.

**There are three types of techniques available which Data-link layer may deploy to control the errors by Automatic Repeat Requests (ARQ):**

### 1 .Stop-and-wait ARQ :-

The following transition may occur in Stop-and-Wait ARQ:

- The sender maintains a timeout counter.
- When a frame is sent, the sender starts the timeout counter.
- If acknowledgement of frame comes in time, the sender transmits the next frame in queue.
- If acknowledgement does not come in time, the sender assumes that either the frame or its acknowledgement is lost in transit. Sender retransmits the frame and starts the timeout counter.
- If a negative acknowledgement is received, the sender retransmits the frame.

### 2 .Go-Back-N ARQ :-

Stop and wait ARQ mechanism does not utilize the resources at their best.When the acknowledgement is received, the sender sits idle and does nothing. In Go-Back-N ARQ method, both sender and receiver maintain a window.

The sending-window size enables the sender to send multiple frames without receiving the acknowledgement of the previous ones. The receiving-window enables the receiver to receive multiple frames and acknowledge them. The receiver keeps track of incoming frame's sequence number.

When the sender sends all the frames in window, it checks up to what sequence number it has received positive acknowledgement. If all frames are positively acknowledged, the sender sends next set of frames. If sender finds that it has received NACK or has not receive any ACK for a particular frame, it retransmits all the frames after which it does not receive any positive ACK.

### 3 .Selective-Reject ARQ :-

- Selective-Reject ARQ technique is more efficient than Go-Back-n ARQ.
- In this technique, only those frames are retransmitted for which negative acknowledgement (NAK) has been received.
- The receiver storage buffer keeps all the damaged frames on hold until the frame in error is correctly received.
- The receiver must have an appropriate logic for reinserting the frames in a correct order.
- The sender must consist of a searching mechanism that selects only the requested frame for retransmission.

## 2 . SYNCHRONOUS AND ASUNCHRONOUS TRANSMISSION DIFFERENTIATE ? - 5 marks

Synchronous and Asynchronous Transmission are the type of serial data transmission in which data is transmitted between sender and receiver based on the clock pulse used for synchronization.

| S.NO | Synchronous Transmission | Asynchronous Transmission |
|---|---|---|

| | | |
|---|---|---|
| 1. | In Synchronous transmission, Data is sent in form of blocks or frames. | In asynchronous transmission, Data is sent in form of byte or character. |
| 2. | Synchronous transmission is fast. | Asynchronous transmission is slow. |
| 3. | Synchronous transmission is costly. | Asynchronous transmission is economical. |
| 4. | In Synchronous transmission, time interval of transmission is constant. | In asynchronous transmission, time interval of transmission is not constant, it is random. |
| 5. | In Synchronous transmission, There is no gap present between data. | In asynchronous transmission, There is present gap between data. |
| 6. | Efficient use of transmission line is done in synchronous transmission. | While in asynchronous transmission, transmission line remains empty during gap in character transmission. |
| 7. | Synchronous transmission needs precisely synchronized clocks for the information of new bytes. | Asynchronous transmission have no need of synchronized clocks as parity bit is used in this transmission for information of new bytes. |

## 2 . DATA LINK CONTROLS - EXPLAIN ? - (N.B)

## SECTIONS INCLUDED - RANDOM / CONTROL ACCESS PROTOCOLS - (ALOHA , CSMA , CSMA/CD,CSMA/CA) - 5 MARKS

# Data Link Control :

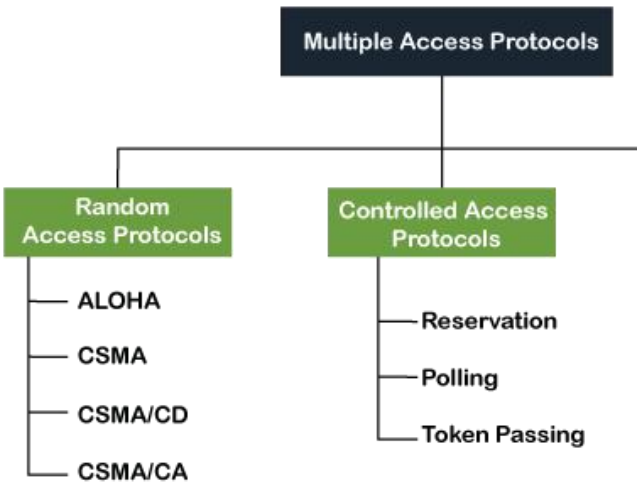
A data link control is a reliable channel for transmitting data over a dedicated link using various techniques such as framing, error control and flow control of data packets in the computer network.

## What is a multiple/MEDIA access protocol?

When a sender and receiver have a dedicated link to transmit data packets, the data link control is enough to handle the channel. Suppose there is no dedicated path to communicate or transfer the data between two devices. In that case, multiple stations access the channel and simultaneously transmits the data over the channel. It may create collision and cross talk. Hence, the multiple access protocol is required to reduce the collision and avoid crosstalk between the channels.

For example, suppose that there is a classroom full of students. When a teacher asks a question, all the students (small channels) in the class start answering the question at the same time (transferring the data simultaneously). All the students respond at the same time due to which data is overlap or data lost. Therefore it is the responsibility of a teacher (multiple access protocol) to manage the students and make them one answer.

Following are the types of multiple/MEDIA access protocol that is subdivided into the different process as:




## A. Random Access Protocol :-

In this protocol, all the station has the equal priority to send the data over a channel. In random access protocol, one or more stations cannot depend on another station nor any station control another station. Depending on the channel's state (idle or busy), each station transmits the data frame. However, if more than one station sends the data over a channel, there may be a collision or data conflict. Due to the collision, the data frame packets may be lost or changed. And hence, it does not receive by the receiver end.

Following are the different methods of random-access protocols for broadcasting frames on the channel.

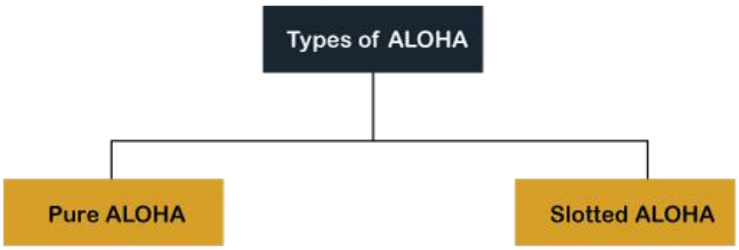
- Aloha
- CSMA
- CSMA/CD
- CSMA/CA

## * ALOHA :-

It is designed for wireless LAN (Local Area Network) but can also be used in a shared medium to transmit data. Using this method, any station can transmit data across a network simultaneously when a data frameset is available for transmission.

**Aloha Rules :-**

1. Any station can transmit data to a channel at any time.
2. It does not require any carrier sensing.
3. Collision and data frames may be lost during the transmission of data through multiple stations.
4. Acknowledgment of the frames exists in Aloha. Hence, there is no collision detection.
5. It requires retransmission of data after some random amount of time.




## ** Pure Aloha :-

Whenever data is available for sending over a channel at stations, we use Pure Aloha. In pure Aloha, when each station transmits data to a channel without checking whether the channel is idle or not, the chances of collision may occur, and the data frame can be lost. When any station transmits the data frame to a channel, the pure Aloha waits for the receiver's acknowledgment. If it does not acknowledge the receiver end within the specified time, the station waits for a random amount of time, called the backoff time (Tb). And the station may assume the frame has been lost or destroyed. Therefore, it retransmits the frame until all the data are successfully transmitted to the receiver.

1. The total vulnerable time of pure Aloha is 2 * Tfr.
2. Maximum throughput occurs when G = 1/ 2 that is 18.4%.
3. Successful transmission of data frame is S = G * e ^ - 2 G.

## Slotted Aloha :-

The slotted Aloha is designed to overcome the pure Aloha's efficiency because pure Aloha has a very high possibility of frame hitting. In slotted Aloha, the shared channel is divided into a fixed time interval called **slots**. So that, if a station wants to send a frame to a shared channel, the frame can only be sent at the beginning of the slot, and only one frame is allowed to be sent to each slot. And if the stations are unable to send data to the beginning of the slot, the station will have to wait until the beginning of the slot for the next time. However, the possibility of a collision remains when trying to send a frame at the beginning of two or more station time slot.

1. Maximum throughput occurs in the slotted Aloha when G = 1 that is 37%.
2. The probability of successfully transmitting the data frame in the slotted Aloha is S = G * e ^ - 2 G.
3. The total vulnerable time required in slotted Aloha is Tfr.

## * CSMA (Carrier Sense Multiple Access) :-

It is a **carrier sense multiple access** based on media access protocol to sense the traffic on a channel (idle or busy) before transmitting the data. It means that if the channel is idle, the station can send data to the channel. Otherwise, it must wait until the channel becomes idle. Hence, it reduces the chances of a collision on a transmission medium.

### CSMA Access Modes :-

**1-Persistent:** In the 1-Persistent mode of CSMA that defines each node, first sense the shared channel and if the channel is idle, it immediately sends the data. Else it must wait and keep track of the status of the channel to be idle and broadcast the frame unconditionally as soon as the channel is idle.

**Non-Persistent:** It is the access mode of CSMA that defines before transmitting the data, each node must sense the channel, and if the channel is inactive, it immediately sends the data. Otherwise,

the station must wait for a random time (not continuously), and when the channel is found to be idle, it transmits the frames.

**P-Persistent:** It is the combination of 1-Persistent and Non-persistent modes. The P-Persistent mode defines that each node senses the channel, and if the channel is inactive, it sends a frame with a **P** probability. If the data is not transmitted, it waits for a (**q = 1-p probability**) random time and resumes the frame with the next time slot.

**O- Persistent:** It is an O-persistent method that defines the superiority of the station before the transmission of the frame on the shared channel. If it is found that the channel is inactive, each station waits for its turn to retransmit the data.

## * CSMA/ CD :-

It is a **carrier sense multiple access/ collision detection** network protocol to transmit data frames. The CSMA/CD protocol works with a medium access control layer. Therefore, it first senses the shared channel before broadcasting the frames, and if the channel is idle, it transmits a frame to check whether the transmission was successful. If the frame is successfully received, the station sends another frame. If any collision is detected in the CSMA/CD, the station sends a jam/ stop signal to the shared channel to terminate data transmission. After that, it waits for a random time before sending a frame to a channel.

## * CSMA/ CA :-

It is a **carrier sense multiple access/collision avoidance** network protocol for carrier transmission of data frames. It is a protocol that works with a medium access control layer. When a data frame is sent to a channel, it receives an acknowledgment to check whether the channel is clear. If the station receives only a single (own) acknowledgments, that means the data frame has been successfully transmitted to the receiver. But if it gets two signals (its own and one more in which the collision of frames), a collision

of the frame occurs in the shared channel. Detects the collision of the frame when a sender receives an acknowledgment signal.

Following are the methods used in the CSMA/ CA to avoid the collision:

**Interframe space**: In this method, the station waits for the channel to become idle, and if it gets the channel is idle, it does not immediately send the data. Instead of this, it waits for some time, and this time period is called the **Interframe** space or IFS. However, the IFS time is often used to define the priority of the station.

**Contention window**: In the Contention window, the total time is divided into different slots. When the station/ sender is ready to transmit the data frame, it chooses a random slot number of slots as **wait time**. If the channel is still busy, it does not restart the entire process, except that it restarts the timer only to send data packets when the channel is inactive.

**Acknowledgment**: In the acknowledgment method, the sender station sends the data frame to the shared channel if the acknowledgment is not received ahead of time.

## B. Controlled Access Protocol :-

It is a method of reducing data frame collision on a shared channel. In the controlled access method, each station interacts and decides to send a data frame by a particular station approved by all other stations. It means that a single station cannot send the data frames unless all other stations are not approved. It has three types of controlled access: **Reservation, Polling**, and **Token Passing**.

### 3 . WIRED LAN ?

# 8. Wired LAN

A local area network (LAN) is a computer network that interconnects computers within a limited area such as a residence, school, laboratory, university campus or office building. A LAN may be wired, wireless, or a combination of the two.

"Wired" is the term that refers to any physical medium consisting of cables. The cables can be copper wire, twisted pair or fibre optic. A wired LAN uses cables to connect devices, such as laptop or desktop computers, to the Internet or another network.

Although a LAN can be used as an isolated network to connect computers in an organization for the sole purpose of sharing resources, most LANs today are also linked to a wide area network(WAN) or the Internet.

The LAN market has seen several technologies such as Ethernet, Token Ring, Token Bus, FDDI (Fibre Distribution Data Interface), and ATM (Asynchronous Transfer Mode) LAN. Almost every LAN except Ethernet has disappeared from the marketplace because Ethernet was able to update itself to meet the needs of the time.

## 4 .EXPLAIN IEEE STANDARDS ?

**In 1985, the Computer Society of the IEEE(Institute of Electrical and Electronics Engineers) started a project, called Project 802, to set standards to enable intercommunication among equipment from a variety of manufacturers. It is a way of specifying functions of the physical layer and the data link layer of major LAN protocols. Project 802 has split the data link layer into two different sublayers: logical link control (LLC) and media access control (MAC).**

The IEEE 802 family of standards include:

| IEEE STD | Application |
|---|---|
| IEEE 802.1 | Bridging (networking) and network management |
| IEEE 802.2 | Logical link layer |
| IEEE 802.3 | Ethernet (CSMA/CD) |
| IEEE 802.4 | Token bus (disbanded) |
| IEEE 802.5 | Defines a MAC layer for a token ring (inactive) |
| IEEE 802.6 | Metropolitan Area Networks (disbanded) |
| IEEE 802.7 | Broadband LAN using coaxial cable (disbanded) |
| IEEE 802.8 | Fibre optic TAG (disbanded) |
| IEEE 802.9 | Integrated Services LAN (disbanded) |
| IEEE 802.10 | Interoperable LAN Security (disbanded) |
| IEEE 802.11 | Wireless LAN and mesh (Wi-Fi certification) |
| IEEE 802.12 | Demand Priority (disbanded) |

| IEEE STD | Application |
|---|---|
| IEEE 802.13 | Not used |
| IEEE 802.14 | Cable modems (disbanded) |
| IEEE 802.15 | Wireless PAN |
| IEEE 802.15.1 | Blue-tooth certification |
| IEEE 802.15.4 | ZigBee Certification |
| IEEE 802.16 | Broadband Wireless Access (WiMax Certification) |
| IEEE 802.16e | (Mobile) Broadband Wireless Access |
| IEEE 802.17 | Resilient Packet Ring |

## 5 . EXPLAIN FDDI ?

**FDDI** stands for **Fiber Distributed Data Interface**. It is a set of ANSI and ISO guidelines for information transmission on fiber-optic lines in Local Area Network (LAN) that can expand in run upto 200 km (124 miles). The FDDI convention is based on the **token ring protocol.**

In expansion to being expansive geographically, an FDDI neighborhood region arranges can support thousands of clients. FDDI is habitually utilized on the spine for a Wide Area Network(WAN).

An FDDI network contains **two token rings,** one for possible backup in case the essential ring falls flat.
The primary ring offers up to 100 Mbps capacity. In case the secondary ring isn't required for backup, it can also carry information, amplifying capacity to 200 Mbps. The single ring can amplify the most extreme remove; a double ring can expand 100 km (62 miles).

**Characteristics of FDDI :-**

- FDDI gives 100 Mbps of information throughput.
- FDDI incorporates two interfaces.
- It is utilized to associate the equipment to the ring over long distances.
- FDDI could be a LAN with Station Management.
- Allows all stations to have broken even with the sum of time to transmit information.
- FDDI defines two classes of traffic viz. synchronous and asynchronous.

## 6 . EXPLAIN ISDN ?

ISDN was first defined in the CCITT red book in 1988.The **Integrated Services of Digital Networking**, in short ISDN is a telephone network based infrastructure that allows the transmission of voice and data simultaneously at a high speed with greater efficiency. This is a circuit switched telephone network system, which also provides access to Packet switched networks.

**SERVICES :-**

**Bearer services** – allows user to send information from one device to another on a network. The transfer voice, data and video take place without processing or changing the information. It belongs to first 3 layers of OSI model(physical, data link, network). It can be provided using circuit or packet switched networks.

**Teleservices – These are value-added services provided by the network.** The information may be processed and changed. It belongs to 4-7 layers(transport, session, presentation, application). It includes telephony, telefax, videotex, and teleconferencing .

**Supplementary Services** – provide additional functionality to the bearer services and teleservices. Examples are call waiting, message handling.

## 7 . SWITCHING TECHNIQUES ( PACKET , MESSAGE ,CIRCUIT SWITCHING) ? - ESSAY QUESTION (N.B)

# SWITCHING TECHNIQUES

A network consists of many switching devices. In order to connect multiple devices, one solution could be to have a point to point connection in between pair of devices. But this increases the number of connection. The other solution could be to have a central device and connect every device to each other via the central device which is generally known as star Topology. Both these methods are wasteful and impractical for very large network. The other topology also can not be used at this stage. Hence a better solution for this situation is SWITCHING. A switched network is made up of a series of interconnected nodes called switches.

## Types of switching Techniques:-

There are basically three types of switching methods,

1) circuit switching
2) Packet switching
3) Message switching.

## Circuit Switching

Circuit switching is a technique that directly connects the sender and the receiver in an unbroken path. For example, take telephone switching equipment establishes a path that connects the caller's and recievers telephone by making a physical connection. Routing decisions in circuit must be made when the circuit is first established, but there are no decisions made after that time. A complete end to end path must exist before communication can take place. Once the connection has been initiated and completed, the destination device must acknowledge that it is ready and able to carry on a transfer.

### Advantages :-

- The communication channel is end to end dedicated.

### Disadvantages :-

- More bandwidth is required
- connection establishment time is more.
- More expensive than any other switching techniques.

## Message Switching

In message switching there is no dedicated path required between two communicating devices, because the message switching is the follow the connectionless network, with message switching there is no need to establish dedicated path between two stations. when a station sends a message, the destination address is appended to the message.

The message is then transmitted through the network in its entirety, from node to node. Each node recieves the entire message, stores it in its entirety on disk and then transmits the message to the next node. This type of network is called a store and forward network.

Advantages :-

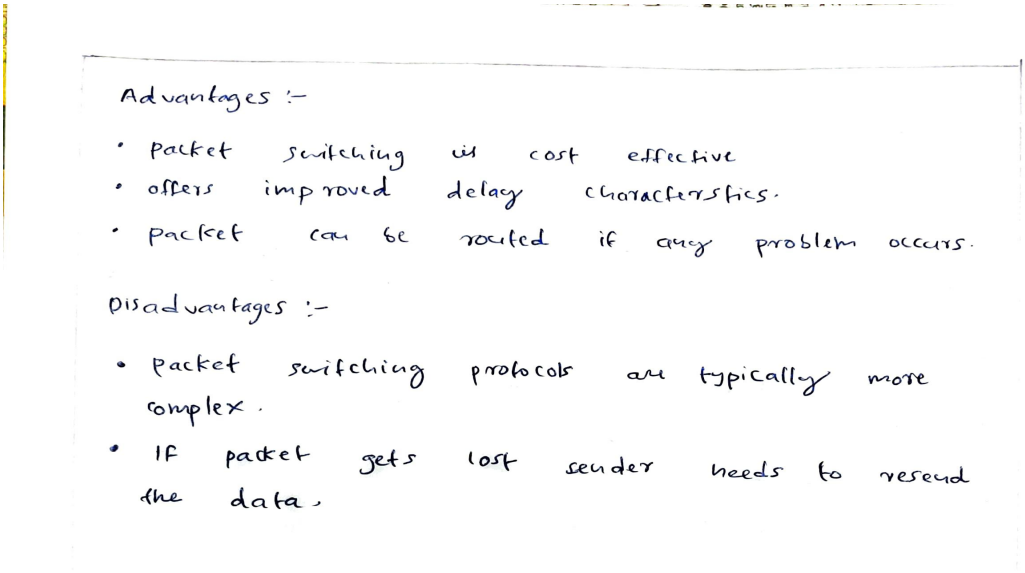
- Efficient traffic management
- Large storing capacity.

Disadvantages :-

- Is not compatible with interactive applications.

## Packet Switching

The packet switching is a switching technique in which the message is sent in one go, but it is divided into smaller pieces, and they are sent individually. The message splits into smaller pieces known as packets and packets are given a unique number to identify their order at the recieving end. Every packet contain some information in its headers such as source address, destination address and sequence number. Packets will travel accross the network, taking the shortest path as possible. All the packets are reassembled at the recieving end in correct order. If any packet is missing or corrupted, then the message will be sent to resend the message.



Advantages :-

- Packet switching is cost effective
- offers improved delay characteristics.
- Packet can be routed if any problem occurs.

Disadvantages :-

- Packet switching protocols are typically more complex.
- If packet gets lost sender needs to resend the data.

## MODULE 4 :

### 1. ADVANTAGES AND DISADVANTAGES OF OPTICAL FIBRE ?

Advantages of Optical Fiber :-

•Greater bandwidth & faster speed—Optical fiber cable supports extremely high bandwidth and speed. The large amount of information that can be transmitted per unit of optical fiber cable is its most significant advantage.

•Cheap—Long, continuous miles of optical fiber cable can be made cheaper than equivalent lengths of copper wire. With numerous vendors swarm to compete for the market share, optical cable price would sure to drop.

•Thinner and light-weighted—Optical fiber is thinner, and can be drawn to smaller diameters than copper wire. They are of smaller size and light weight than a comparable copper wire cable, offering a better fit for places where space is a concern.

•Higher carrying capacity—Because optical fibers are much thinner than copper wires, more fibers can be bundled into a given-diameter cable. This allows more phone lines to go over

the same cable or more channels to come through the cable into your cable TV box.

•Less signal degradation—The loss of signal in optical fiber is less than that in copper wire.

•Light signals—Unlike electrical signals transmitted in copper wires, light signals from one fiber do not interfere with those of other fibers in the same fiber cable. This means clearer phone conversations or TV reception.

•Long lifespan—Optical fibers usually have a longer life cycle for over 100 years.

Disadvantages of Optical Fiber :-

• Low power—Light emitting sources are limited to low power. Although high power emitters are available to improve power supply, it would add extra cost.

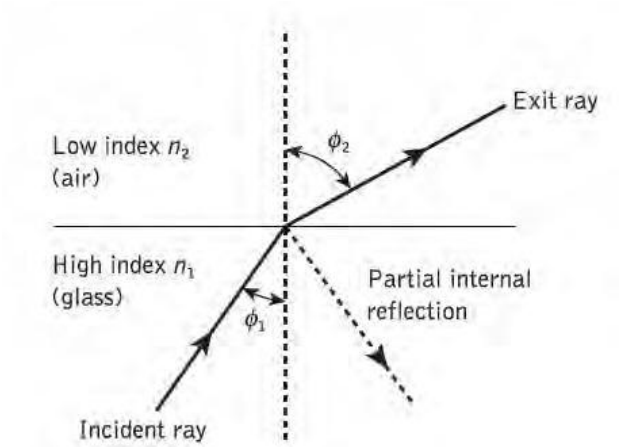
•Fragility—Optical fiber is rather fragile and more vulnerable to damage compared to copper wires. You'd better not to twist or bend fiber optic cables too tightly.

•Distance—The distance between the transmitter and receiver should keep short or repeaters are needed to boost the signal.

**2 . RAY THEORY OF LIGHT ? - 5 MARKS**

A ray is usually known as a narrow beam of light. It is known as the classical theory of light or geometrical optics. This ray theory only describes limited amount of properties of light such as refraction and reflection. A light ray can be defined as the line or curve perpendicular to the wavefronts of light. This definition of light ray makes it actually collinear to the wave vector. The refraction of a light can be described using rays.

Most of the simple calculation like magnification and distance of the image of optical systems such as telescopes, microscopes or simple lens systems are carried out using ray theory of light.




Ray theory can well describe the light propagation in terms of rays. This simplification is useful in practice; it is an excellent approximation when the dimensions of the objects are much greater than the light's wavelength. Ray theory only describes limited amount of properties of light such as refraction and reflection. It does not describe phenomena such as diffraction, which require wave theory of light.

The simplifying assumptions of ray theory include that light rays:

■ Propagate in straight-line paths as they travel in a

homogeneous medium.

■ Bend, and in particular circumstances may split in two, at the interface between two dissimilar media

Follow curved paths (refraction) in a medium in which the refractive index changes. The refracted ray will lie in the plane of incidence. Snell's Law will give the relationship between the angles of incidence and refraction.

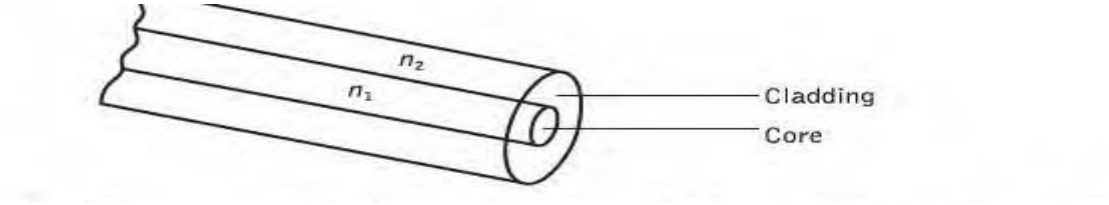
■ May be absorbed or reflected. Reflected ray lies in the plane of incidence and angle of incidence will be equal to the angle

of reflection.

## 3 . OPTICAL FIBRE WAVE GUIDES ?

### Optical Fiber Waveguides :

An optical waveguide is a spatially inhomogeneous structure for guiding light, i.e., for restricting the spatial region in which light can propagate. Usually, a waveguide contains a region of increased refractive index(measure of bending of a light ray when passing from one medium to another.), compared with the surrounding medium (called cladding). Cladding is the application of one material over another to provide a skin or layer. A circular dielectric waveguide or fiber optic has an internal core that has a higher index of refraction than the cladding.




## 4 . EXPLAIN OPTICAL FIBRE MATERIALS ?

### Fibre Materials :

Requirements for selecting material for optical fibers :

1) Must be possible to make long, thin and flexible fibers from the material

2) Material must be transparent at a particular optical wavelength to guide light effectively

3) Physically compatible materials that have slightly different refractive indices for core and cladding must be available

**Materials that satisfy these requirements are glass and plastic.**

### ** Glass Fibers :-

Largest category of optically transparent glasses from which optical fibers are made consists of oxide of glasses. The most common oxide is silica ($SiO_2$). To produce two similar materials that have slightly different indices of refraction for core and cladding, either fluorine or various oxides (referred to as dopants) such as :

**$B_2O_3$, $GeO_2$ or**

**$P_2O_5$ are added to silica. An example is:**

**$GeO_2$ – $SiO_2$ for core , $SiO_2$ for cladding**

****Plastic Optical Fibers :-**

Polymer(plastic) Optical Fibers (POF) are less widely used because of higher attenuation than glass fibers. Its main use is in short distance applications. The core of these fibers is either polymethylmethacrylate(PMMA POF) or a

perfluorinated polymer(PF POF).

## 5 . LIGHT EMITTING DIODE (LED) - EXPLAIN ?

**Light Emitting Diodes (LEDs) :**

- **A light-emitting diode (LED) is a p-n junction diode, which emits light when activated or forward biased.**

- **The n-type and p-type semiconductors are semiconductors into which impurities are added. In n-type semiconductors, free electrons are the majority charge carriers whereas in p-type semiconductors , holes (positively charged) are the majority charge carriers.**

- **When the n-type semiconductor is joined with the p-type semiconductor, a p-n junction is formed. The majority charge carriers diffuse across the junction, electrons fill holes in p-side and holes appear on n-side. An electric field appears as a result and prevents further movement once equilibrium is attained.**

**• Under forward biased condition, the p-type semiconductor is connected to the positive terminal of battery whereas; the n-type semiconductor is connected to the negative terminal of battery. Under reverse biased condition, the p-type semiconductor is connected to the negative terminal of battery whereas; the n-type semiconductor is connected to the positive terminal of battery.**

## 5 . PHOTO DETECTOR - EXPLAIN ?

## Photodetectors :

**• The function of a detector is to convert the received optical signal into an electrical signal, which is then amplified before further processing. Optical detectors perform the exact opposite function of that of the optical sources; that is, they convert electric power into optical power.**

**• The two photodetector devices most commonly used in optical fiber communications systems are the PIN and APD devices.**

**• PIN – is the abbreviation of P-region, I-Intrinsic- N-region semiconductor diode [Intrinsic is the opposite of extrinsic in the sense they are semiconductors without doping/added impurities].When a photon is incident upon a semiconductor photodetector device with energy larger than the bandgap energy of that device, the energy of the photon is absorbed by the bandgap and an electron-hole pair is generated across the bandgap.**

**The term "band gap" refers to the energy difference between the top of the valence band and the bottom of the conduction band. The absorbed photons trigger photocurrent in the external circuitry. The generated photocurrent from the PIN-photodetector device develops a potential difference across the load resistance RL.**

• APD(Avalanche photodiode) internally multiply primary signal photocurrent before it enters input circuitry of amplifier. It is similar to PIN - diodes with only one exception; that is, the addition of a high intensity electric field region. In this region, the primary electron-hole

pairs generated by the incident photons are able to absorb enough kinetic energy from the strong electric field to collide with atoms present in this region, thus generating more electron-hole pairs. This process of generating more than one electron-hole pair from one incident photon through the ionization process is referred to as the “avalanche effect”. Photocurrent generated by an APD photodetector device exceeds the current generated by a PIN device. Avalanche photodetectors exhibit higher noise levels than PIN devices.

## SHORT ANSWER QSTNS :- ( 3 MARKS ) _ MODULE 1 TO 4 _

## 1 . DEFINE TOPOLOGY ?

Network topology refers to the manner in which the links and nodes of a network are arranged to relate to each other. ... A network topology diagram helps visualize the communicating devices, which are modeled as nodes, and the connections between the devices, which are modeled as links between the nodes.

## 2 . DEFINE MODEM ?

Modem is a device that enables a computer to send or receive data over telephone or cable lines. The data stored on the computer is digital whereas a telephone line or cable wire can transmit only analog data. The main function of the modem is to convert digital signal into analog and vice versa.

## 3 . DEFINE BIT ORIENTED PROTOCOL ?

A bit-oriented protocol is a communications protocol that sees the transmitted data as an opaque stream of bits with no semantics, or meaning. Control codes are defined in terms of bit sequences instead of characters. ... Each frame begins and ends with a special bit pattern 01111110, called a flag byte.

## 4 . WHAT IS ETHERNET ?

Ethernet is primarily a standard communication protocol used to create local area networks. It transmits and receives data through cables. This

facilitates network communication between two or more different types of network cables such as from copper to fiber optic and vice versa**.**

## 5 . WHAT IS NETWORK ?

A network consists of 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.

Two very common types of networks include:

Local Area Network (LAN)

Wide Area Network (WAN)

## 6 . EXPLAIN CUTOFF WAVELENGTH ?

The cutoff wavelength is the minimum wavelength in which a particular fiber still acts as a single mode fiber. Above the cutoff wavelength, the fiber will only allow the LP01 mode to propagate through the fiber (fiber is a single mode fiber at this wavelength).

## 7 . Applications of Optical Fiber Communication ?

•Alternatives to conventional copper twisted-pair cables in telephone system.

•It can be placed near high voltage power lines, as it doesn’t suffer from electromagnetic interference.

•Used in broadcast television, cable television, remote monitoring and surveillance.

•Used in transmission of digital data generated by computers such as between CPU to peripherals, CPU to CPU.

•Military applications include communications, command and control links on ships and aircraft, data link forsatellite earth stations.

•Used in sensors such as temperature sensors, position sensors, gyroscope

**ALL THE BEST**

**CONTACT : 7025190151**