

MODULE 2: PHYSICAL LAYER

Q.1) WRITE A NOTE ON TWISTED PAIR CABLE AND COMPARE THEM.

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Twisted Pair Cables

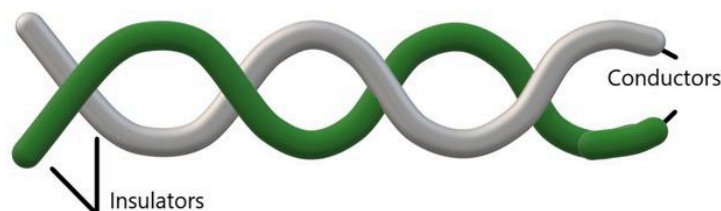
These are a type of guided media. It was invented by Alexander Graham Bell.

Twisted pair cables have two conductors that are generally made up of copper and each conductor has insulation.

These two conductors are twisted together, thus giving the name twisted pair cables.

This is very commonly used wired medium, and it is cheaper than the co-axial cable or optical fibre

Applications of Twisted pair cables :



- Twisted Pair cables are used in telephone lines to provide data and voice channels.
- The DSL lines make use of these cables.
- Local Area Networks (LAN) also make use of twisted pair cables.
- They can be used for both analog and digital transmission.
- RJ-45 is a very common application of twisted pair cables.

Types of Twisted Pair Cables

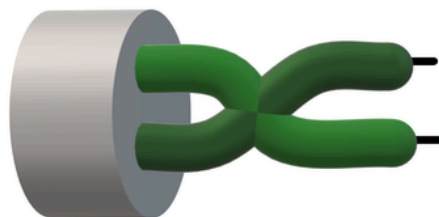
1. Unshielded Twisted Pair (UTP)

- **Description:** a twisted pair consist of two insulated conductors twisted together in the shape of spiral.
- It can be shielded or unshielded. The unshielded twisted pair UTP cables are very cheap and easy to install,
- But they are badly affected by the electromagnetic noise interface.
- When UTP are arranged in pairs, each pair is coded with a different color as defined by the 25-pair color code developed by AT&T Corporation.
- **Uses:** UTP cables are widely used in local area networks (LANs), telephone systems, and Ethernet networks.

Advantages –

1. These cables are cost-effective and easy to install owing to their compact size.
2. They are generally used for short-distance transmission of both voice and data.
3. It is less costly as compared to other types of cables.

Plastic Cover



Disadvantages –

1. The connection established using UTP is not secure.

2. They are efficient only for a distance up to 100 meters and have to be installed in pieces of up to 100 meters.
3. These cables have limited bandwidth.

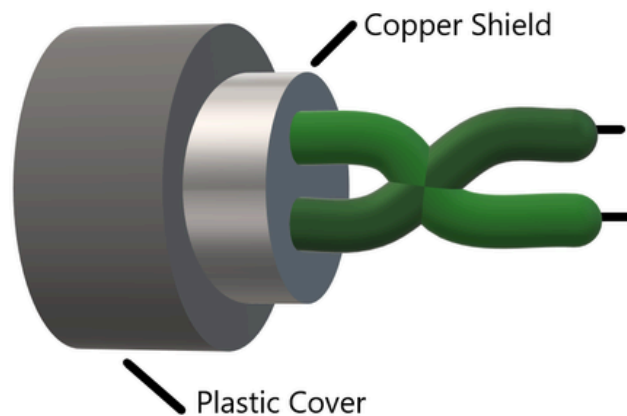
2. Shielded Twisted Pair (STP)

- **Description:** These types of cables have extra insulation or protective covering over the conductors in the form of a copper braid covering.
- This covering provides strength to the overall structure of the cable.
- It also reduces noise and signal interference in the cable.
- The shielding ensures that the induced signal can be returned to the source via ground and only circulate around the shield without affecting the main propagating signal.
- The STP cables are also color-coded like the UTP cables as different color pairs are required for analog and digital transmission.
- These cables are costly and difficult to install.
- **Variants:**
 - **Foiled Twisted Pair (FTP):** Contains a foil shield around all the pairs.
 - **Screened Twisted Pair (ScTP):** Has a screen shield around the entire cable bundle.
 - **Fully Shielded Twisted Pair (S/FTP):** Each pair has its own foil shield, and the cable as a whole has an additional braided shield.

The unique design of coaxial cables helps in carrying high-frequency signals with minimal interference, making them a popular choice for radio frequency (RF) and broadband communications.

Advantages –

1. They are generally used for long-distance communication and transmission and are installed underground.
2. The protective shield prevents external electromagnetic noise penetration into the cable.
3. They have a higher bandwidth as compared to UTP.



Shielded Twisted Pair Cable (STP)

Disadvantages –

1. These cables are very expensive.
2. They require a lot of maintenance which increases the cost more.
3. These can be installed underground only.
4. The length of the segment is similar to UTP for these cables.

Comparison of UTP and STP

Feature	UTP (Unshielded Twisted Pair)	STP (Shielded Twisted Pair)
Shielding	No additional shielding	Shielded with foil or braiding for each pair or cable
Cost	Lower cost due to lack of shielding	Higher cost due to shielding materials
Installation	Easier to install and handle	More difficult to install; requires grounding
Signal Quality	Good in low-interference areas	Better in high-interference environments
Crosstalk Resistance	Moderate	High due to shielding
Typical Use Cases	Office networks, homes, Ethernet	Industrial environments, high EMI areas

Bandwidth	Can support up to 10 Gbps in higher categories (Cat6a)	Can also support high speeds; effective shielding enhances data integrity
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Summary:

Twisted pair cables are integral to modern telecommunications. UTP is affordable and flexible, ideal for office and residential networks. STP, though more costly and complex to install, is well-suited to environments with significant interference. The choice between UTP and STP depends on environmental needs, budget, and required data integrity.

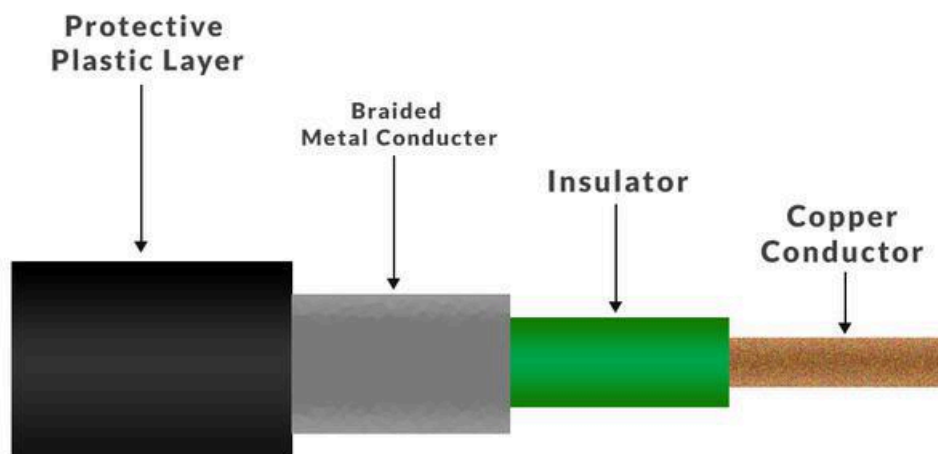
Q.2) WRITE A NOTE ON CO-AXIAL CABLES

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The co-axial cable consist of two core conductors, namely an inner conductor and a braided outer conductor, separated by a dielectric material.

The external conductor is in the form of metallic braid and used for the purpose of shielding.

The co-axial cable may contain one or more co-axial pairs.



Characteristics of Coaxial Cables

- Due to the shield provided, this cable has excellent noise immunity.
- This cable is suitable for point to point or point to multipoint application.
- It has a large bandwidth and low losses.

- co-axial cables are easy to install.
- The signal attenuation is less as compared to twisted pair cable.
- These cables are costlier than twisted pair cables, but they are cheaper than optical fibre cable.

Advantages of Coaxial Cables

1. Excellent noise immunity due to the shield.
2. Large bandwidth.
3. Losses are small.
4. Can support high data rates.
5. Easy to install
6. Less attenuation

Disadvantages of Coaxial Cables

1. Costlier than the twisted pair cable.
2. BNC connectors are required to be used for connection.
3. As a Coaxial cable has multiple layers it is very bulky.

Applications of Coaxial Cables

- Analog telephone networks.
- Digital telephone network.
- Cable TV
- Traditional ethernet LANs
- Digital transmission
- Fast ethernet

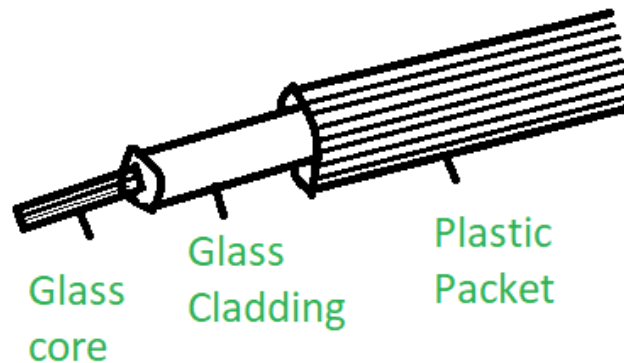
Q.3) WRITE A NOTE ON OPTICAL FIBRE CABLE

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Optical Fiber Cables

Optical fiber cables are a type of data transmission medium that use light pulses to transmit information along a glass or plastic fiber.

Due to their high speed and large data-carrying capacity, optical fiber cables are widely used in telecommunications, internet, and cable TV services.



Characteristics of Optical Fiber Cables

1. Structure:

- It consists of an inner glass core surrounded by a glass cladding which has a low refractive index and a protective covering.

Digital signals are transmitted in the form of intensity-modulated light signals.

Light is launched into the fiber at one end, using a light source such as an LED or laser.

It is detected on the other side, using a photo detector, such as a phototransistor or photodiode.

Optical fiber cables are costlier than the other two types, but they have many advantages over the other two types.

2. **Data Transmission:** Unlike electrical cables, optical fibers transmit data using light pulses, enabling higher speeds and lower attenuation.
3. **Bandwidth Capacity:** Optical fiber cables offer extremely high bandwidth, allowing vast amounts of data to be transmitted over long distances without significant loss.

Advantages of Optical Fiber Cables

- **High Bandwidth and Speed:** Capable of supporting very high data rates, making them ideal for internet, telephone, and television transmissions.
- **Low Signal Attenuation:** Light signals experience very little loss over long distances, reducing the need for repeaters.
- **Immunity to Electromagnetic Interference (EMI):** Optical fibers are not affected by EMI, ensuring clean data transmission.
- **Enhanced Security:** Harder to tap into without detection, making them more secure for sensitive data transmission.
- Small size and light weight.

Disadvantages of Optical Fiber Cables

- **High Cost:** More expensive than copper cables, both in terms of initial cost and installation.
- **Fragility:** Optical fibers are more fragile than metallic cables and require careful handling.
- **Complex Installation and Repair:** Installation and repair require specialized skills and equipment.
- **Limited Flexibility:** Fiber optic cables cannot be bent sharply without risking breakage or signal loss.

Applications of Optical Fiber Cables

1. **Telecommunications:** Widely used for high-speed internet, landline telephony, and cellular networks due to their high bandwidth.
2. **Internet Services:** Backbone of high-speed internet infrastructure, allowing rapid and stable data transmission.
3. **Cable Television:** Often used to deliver high-definition and digital TV signals due to high data transfer capabilities.
4. **Medical Equipment:** Used in medical imaging and diagnostic equipment, as well as in endoscopic procedures, where flexible, thin cables are essential.
5. **Military and Aerospace:** Preferred for secure, high-speed data communication in military and aerospace applications, where EMI immunity and signal integrity are critical.

Summary:

Optical fiber cables are ideal for high-speed, high-bandwidth data transmission over long distances with minimal interference. Though costly and requiring special handling, their advantages in speed, data capacity, and security make them indispensable for modern communication networks, medical technology, and secure communications.

Q.4) COMPARE WIRED AND WIRELESS MEDIA

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Feature	Wired Media	Wireless Media
Definition	Data transmission through physical cables.	Data transmission through air using radio, microwave, or infrared signals.
Installation	Requires physical setup and wiring, which can be time-consuming.	Easier and faster to set up as it doesn't require physical cables.
Suitable for	Short distance communication	Long distance communication
Speed	Generally offers faster and more stable speeds, especially with fiber optics.	Speed can vary based on signal strength and interference.
Examples	Twisted Pair cable, Co-axial cable, fibre optic cable	Radio waves, Microwaves
Interference	Less prone to interference; shielded cables reduce EMI.	More susceptible to interference from other devices and obstacles (walls, weather).
Security	More secure, as physical access to cables is needed to intercept data.	Less secure; signals can be intercepted, though encryption can improve security.
Maintenance	Cables may wear out and need repair or replacement.	Minimal maintenance but may require periodic software updates.
Cost	Generally higher installation cost due to cables and labor.	Often lower installation cost, but network devices can be costly.
Reliability	High reliability with consistent performance, especially in stable environments.	Can be less reliable due to environmental factors affecting signal strength.

