



RIZVI COLLEGE OF ENGINEERING



**Department Of Computer
Engineering**

**Subject : Computer Network
(CSC503)**
Semester V (R-2019)

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Module No : 2	Physical Layer	3Hrs
2.1	Introduction to Communication Electromagnetic Spectrum	
2.2	Guided Transmission Media: Twisted pair, Coaxial, Fiber optics.	

Course Outcome Covered : CO1 : Demonstrate the concepts of data communication at physical layer and compare ISO - OSI model with TCP/IP model.

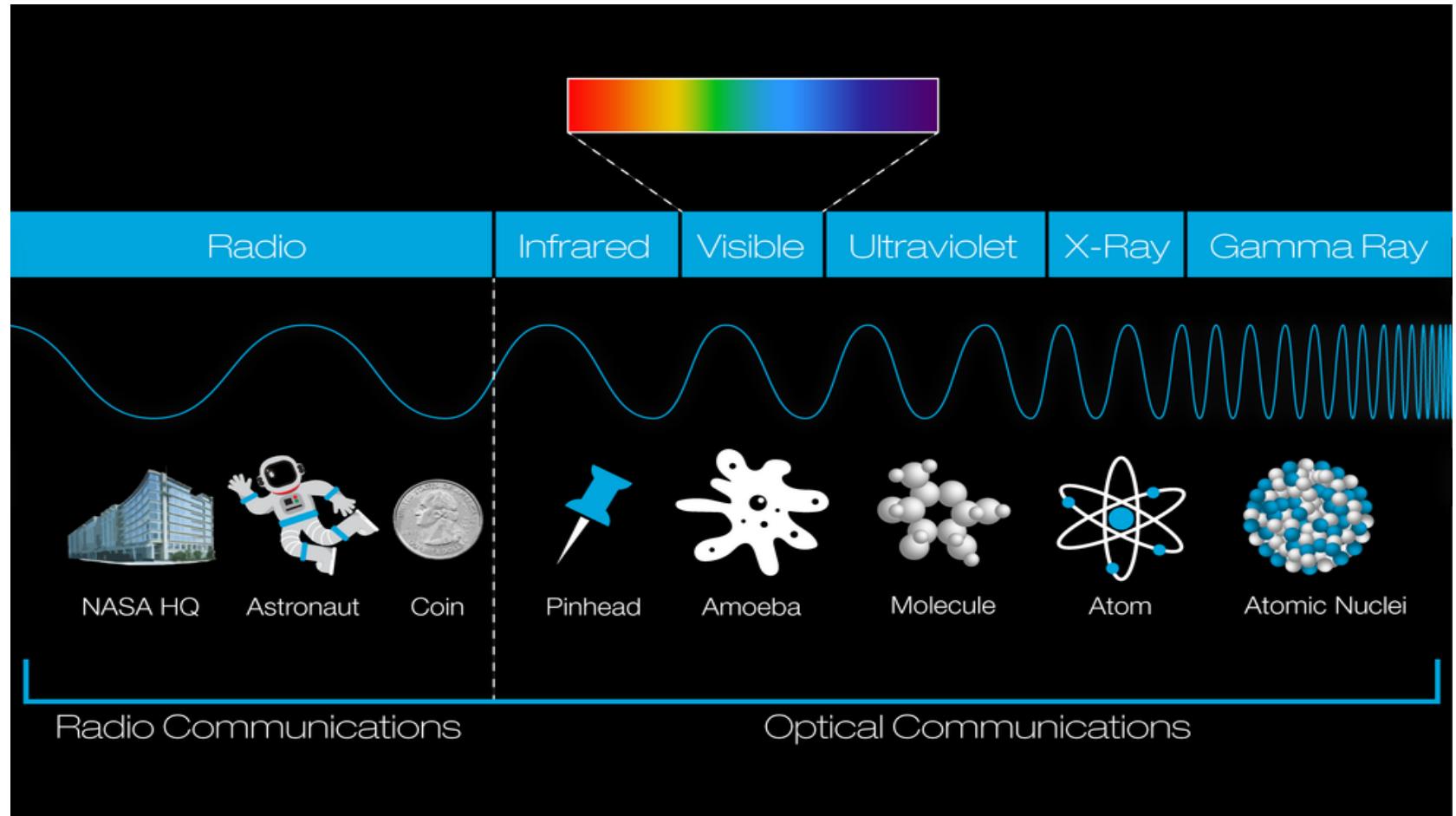
- Books to be referred :
- B.A. Forouzan, Data Communications and Networking, 5th edition, TMH

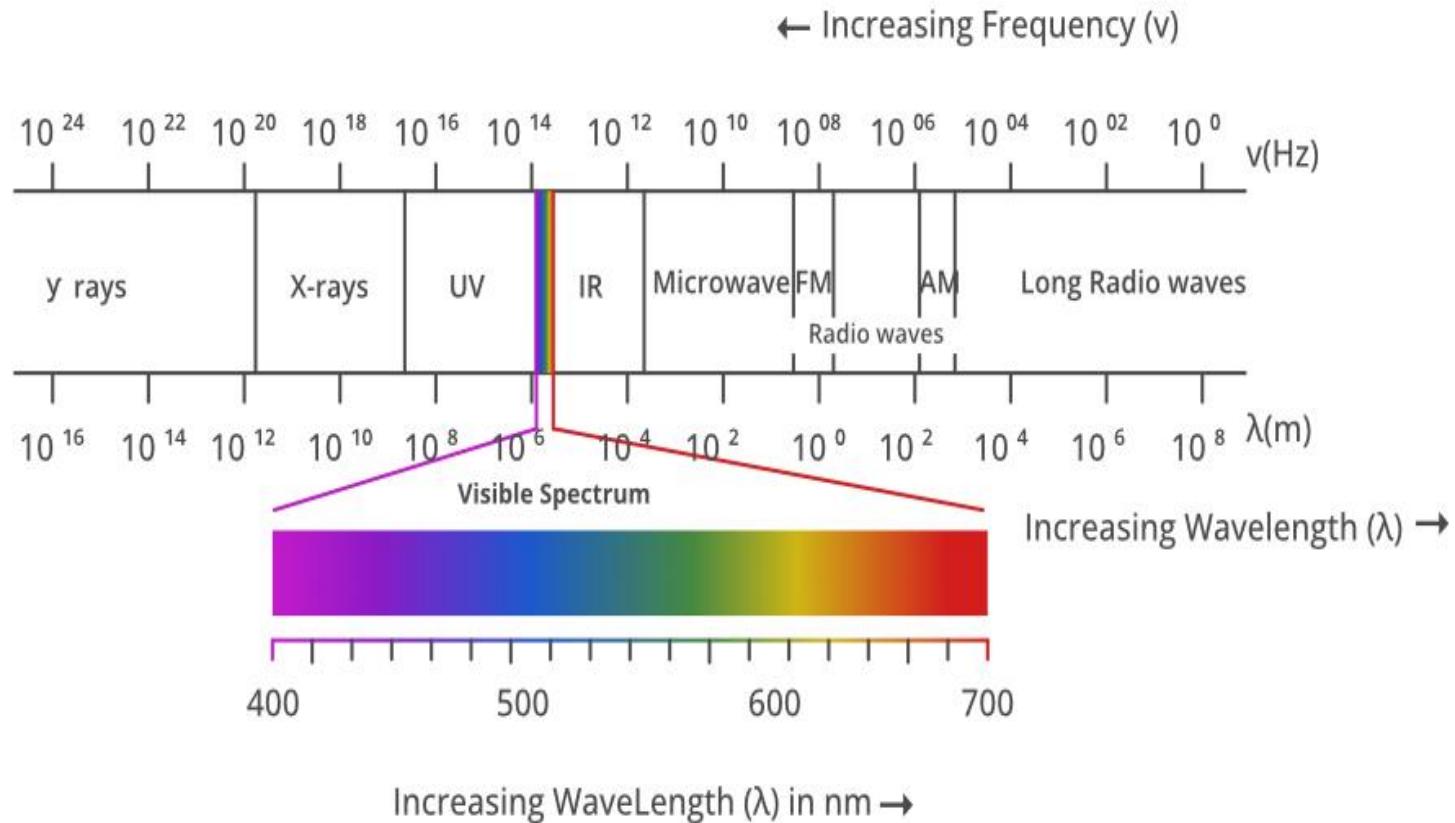


- Introduction to
- Communication Electromagnetic Spectrum
- The electromagnetic spectrum is a collection of frequencies, wavelengths, and photon energies of electromagnetic waves spanning from 1Hz to 10^{25} Hz, equivalent to wavelengths ranging from a few hundred kilometres to a size smaller than the size of an atomic nucleus.



- The electromagnetic spectrum can thus be described as the **range of all types of electromagnetic radiation** in basic terms.
- In a **vacuum**, all electromagnetic waves travel at the same **speed as light**. For different forms of electromagnetic waves, however, the **wavelengths, frequencies, and photon energy will vary**.







- **Electromagnetic Waves in Electromagnetic Spectrum :**
 - Radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation, X-rays, gamma rays, and cosmic rays make up the full range (electromagnetic spectrum) in **decreasing order of frequency** and **rising order of wavelength**.
 - **Radio Waves:**
 - The rapid **travel** of **charged particles** across **conducting wires** causes these waves.
 - Radio, television, and telecom signals are transmitted through them.



- **Radio Waves:**
- These waves have a frequency range of around 3kHz to 300MHz.
- In the ultrahigh-frequency (UHF) band, cellular phones employ radio waves to convey voice communication.



- **Microwaves :**
- Microwaves are a type of electromagnetic radiation that has a frequency of a few gigahertz (GHz).
- Klystrons, magnetrons, and Gunn diodes are unique vacuum tubes that produce them.



- **Infrared Rays** : Infrared waves are produced by hot bodies and molecules and are thus referred to as heatwaves.
- Infrared rays are near the low-frequency or long-wavelength end of the visible light spectrum.
- Night vision goggles make use of these radiations. Infrared light generated by objects in the dark can be read and captured by these devices. Infrared light is used to trace interstellar dust in space.



- **Visible Rays :**
- Visible rays are electromagnetic waves that can be seen with the **naked eye**.
- These can be found in the frequency range of $4 \times 10^{14} \text{ Hz}$ – $7 \times 10^{14} \text{ Hz}$ or the wavelength range of 400nm–700nm.
- The visible light rays **reflected or released** from the **objects around** us assist us in seeing the world, and the **range of visible radiation** is **different** for different creatures.



- **Ultraviolet Rays :**
- Although the sun is the primary source of ultraviolet radiation on Earth, the ozone layer absorbs the majority of UV energy before it reaches the atmosphere.
- UV radiation has a wavelength of 400nm–1nm.
- These radiations are emitted by special lamps and extremely hot bodies, and in big numbers, they can cause significant injury to humans. It tans the skin and creates burns.
- Applications such as LASIK or laser-based eye surgery.



- **X-Rays** : This electromagnetic radiation is found outside of the **ultraviolet (UV)** region of the electromagnetic spectrum and is **extremely valuable** in the **medical field**.
- The wavelength range of X-ray = $1\text{nm}-10^{-3}\text{nm}$.
- By blasting a metal target with high-energy electrons, X-rays can be produced.
- At the airport checkpoint, security agents utilise it to search through passengers' luggage.



- **Gamma-Rays :**
- The universe is the largest gamma-ray generator.
- These rays are in the electromagnetic spectrum's higher frequency region.
- Gamma rays have wavelengths ranging from 10^{-12}m to 10^{-14}m .



Band Name	Full Forms	Frequency Range	Propagation	Uses
ELF	Extremely Low Frequency	30 – 300Hz	Ground	Power line frequencies
LF	Low Frequency	3 – 300 KHz	Ground	Marine Communications, communication over twisted pair
MF	Medium Frequency	300KHz –3MHz	Sky	AM radio, communication over coaxial cables
HF	High Frequency	3 – 30 MHz	Sky	Aircraft and ship communications

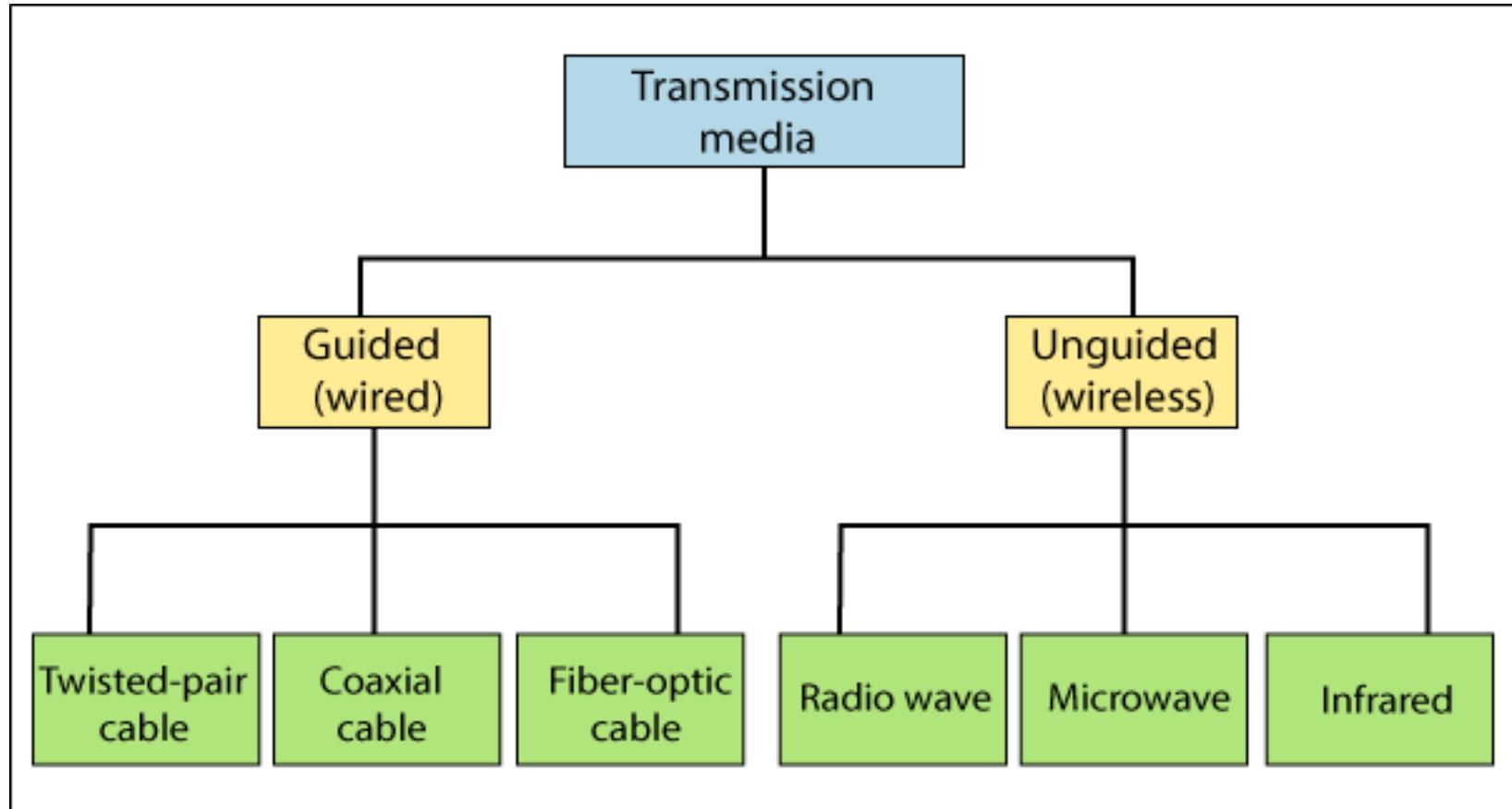


VHF	Very High Frequency	30 – 300 MHz	Sky and Line – of - Sight	FM radio, TV
UHF	Ultra High Frequency	300 MHz – 3GHz	Line – of - Sight	TV, cellular phone
SHF	Super High Frequency	3 – 30 GHz	Line – of - Sight	Satellite, microwave links
EHF	Extremely High Frequency	3 – 300GHz	Line – of - Sight	Radar, satellite
Infrared	Infrared Rays	300 Ghz – 400THz	Line – of - Sight	Consumer electronic goods
Visible Light	Visible Light rays	400 THz – 900 THz	Line – of - Sight	Fiber optic communications



• Guided Transmission Media :

- Transmission media is a communication channel that carries the information from the sender to the receiver. Data is transmitted through the electromagnetic signals
- 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 fiber-based network, the bits in the form of light pulses.





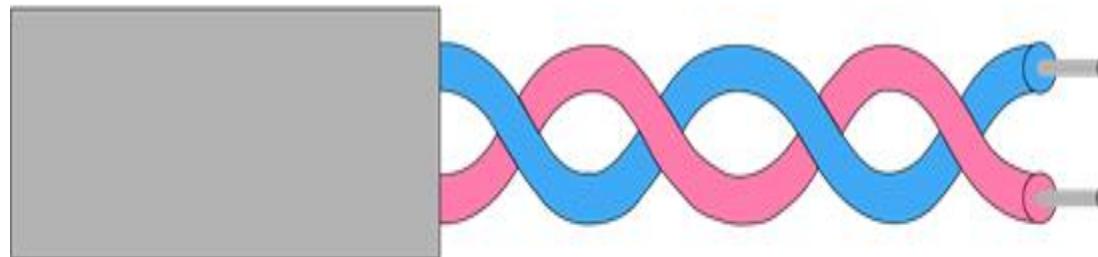
- Guided Media :
- It is defined as the physical medium through which the signals are transmitted. It is also known as Bounded media.
- Twisted pair:
- Twisted pair is a physical media made up of a **pair of cables** twisted with each other.
- A twisted pair cable is **cheap** as compared to other transmission 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**.



Jacket

Twisted Pair

Bare Wire



Twisted Pair

Unshielded Twisted Pair

Shielded Twisted Pair



• **Unshielded Twisted Pair:**

- An unshielded twisted pair is widely used in telecommunication. Following are the categories of the unshielded twisted pair cable:
- **Category 1:** Category 1 is used for telephone lines that have low-speed data.
- **Category 2:** It can support upto 4Mbps.
- **Category 3:** It can support upto 16Mbps.
- **Category 4:** It can support upto 20Mbps. Therefore, it can be used for long-distance communication.
- **Category 5:** It can support upto 200Mbps.



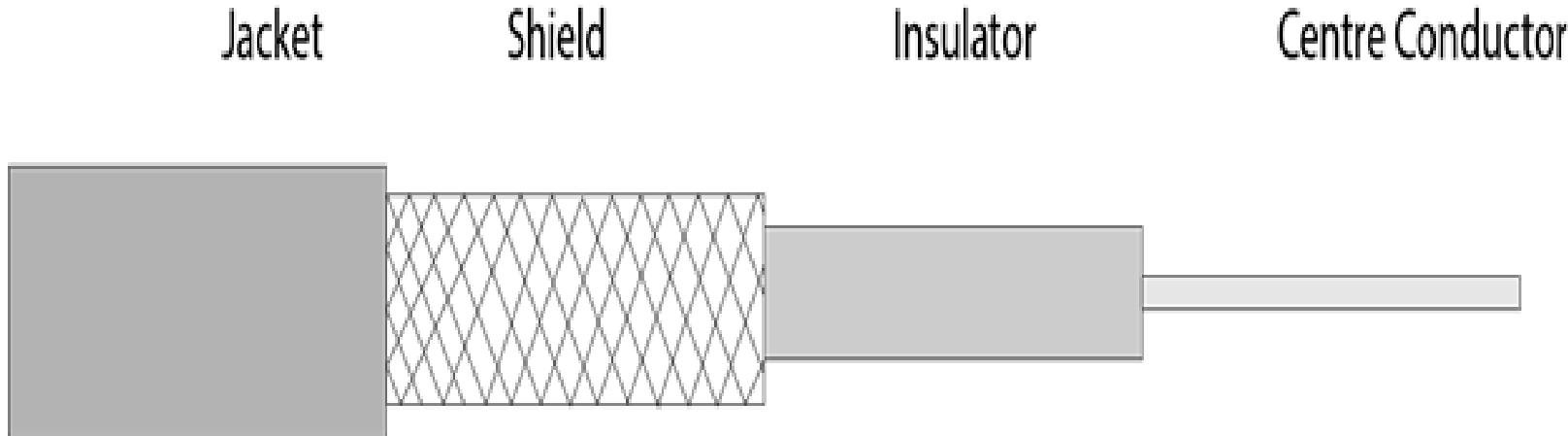
- **Advantages Of Unshielded Twisted Pair:**
- It is **cheap**.
- Installation of the unshielded twisted pair is **easy**.
- It can be used for **high-speed LAN**.
- **Disadvantage:**
- This cable can only be used for **shorter distances** because of **attenuation**.



- **Shielded Twisted Pair :**
- A shielded twisted pair is a cable that contains the **mesh** surrounding the **wire** that allows the higher transmission rate.
- **Characteristics Of Shielded Twisted Pair:**
- The **cost** of the shielded twisted pair cable is **not very high and not very low**.
- An **installation** of STP is **easy**.
- It has **higher capacity** as compared to **unshielded twisted pair cable**.
- It has a **higher attenuation**.
- It is shielded that provides the **higher data transmission rate**.



• Coaxial Cable :





• Coaxial Cable :





- **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.



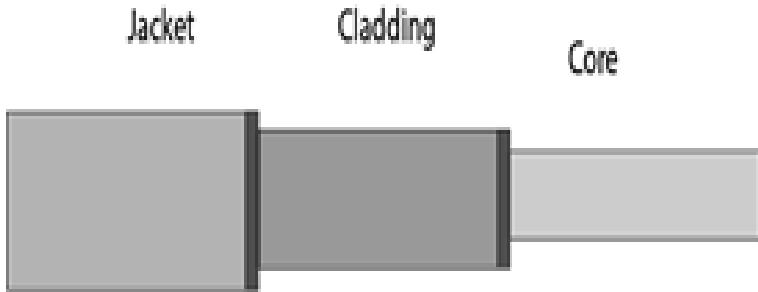
- The middle core is responsible for the data transferring whereas the copper mesh prevents from the EMI(Electromagnetic interference).
- **Coaxial cable is of two types:**
 1. **Baseband transmission:** It is defined as the process of transmitting a single signal at high speed.
 2. **Broadband transmission:** It is defined as the process of transmitting multiple signals simultaneously.



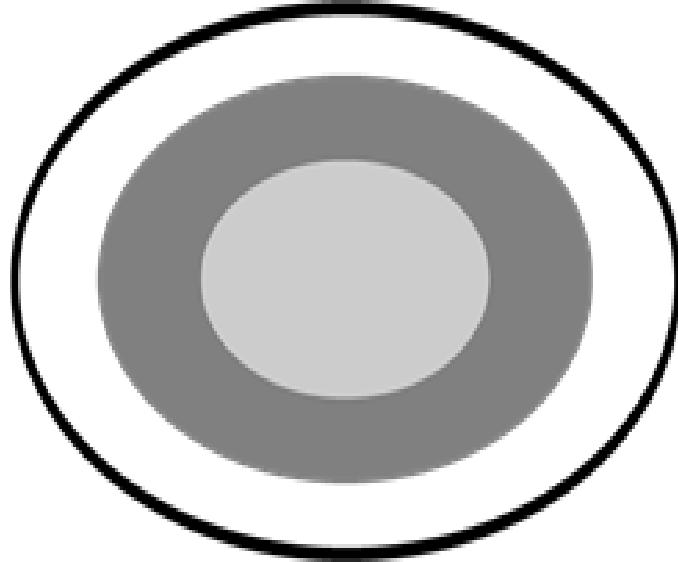
- **Disadvantages Of Coaxial cable:**
- It is **more expensive** as compared to twisted pair cable.
- If any fault occurs in the cable causes the failure in the entire network.



• Optical Fiber Cable :



Side View



End View



- **Optical Fiber Cable :**
- Fiber optic cable is a cable that uses electrical signals for communication.
- Fiber 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.
- Fiber optics provide **faster data transmission** than copper wires.



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



- **Following are the advantages of fiber optic cable over copper:**
- **Greater Bandwidth:** The fiber optic cable provides more bandwidth as compared copper. Therefore, the fibre optic carries more data as compared to copper cable.
- **Faster speed:** Fiber 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 fiber optic cable carries the data at a longer distance as compared to copper cable.



- **Better reliability:** The fiber optic cable is more reliable than the copper cable as it is immune to any temperature changes while it can cause obstruction in the connectivity of copper cable.
- **Thinner and Sturdier:** Fiber optic cable is thinner and lighter in weight so it can withstand more pull pressure than copper cable.



● End Of Module 2