UNIT-2

FIBRE OPTIC COMPONENTS AND DEVICES

2.1) List Various fibre optic components :-

The fibre optic components are used in the transmission path of the optical fiber. These components may be used at the beginning, ending or along the path of the fiber. These components are helpful for transmission of light pulse through the fiber.

Various fiber optic components are :-

① optical Sources (lasers & LED's)
② optical detectors (photo detectors and APD)
③ optical couplers and Splitters
④ connectors
⑤ Isolators
⑥ optical Attenuators.

2.2) State the Need of Splicing in optical fibers :-

→ A permanent joint formed between two individual optical fibers is called Splicing.

→ It is used to establish optical fiber links where small fiber lengths needs to be joined and used in Situations where frequent connections and disconnections are not needed.

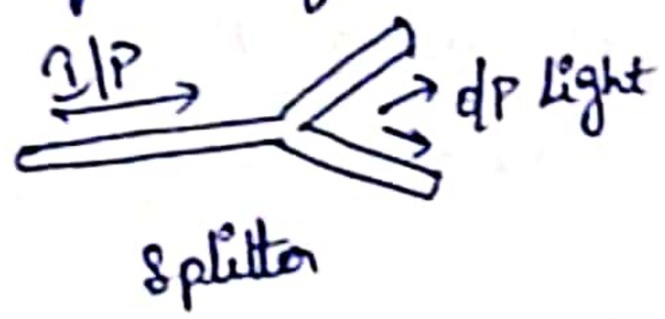
→ It results in low light loss and back reflection than termination.

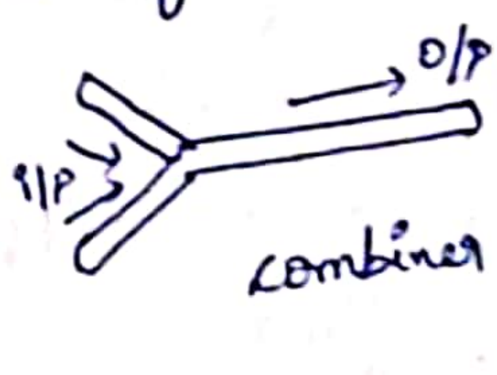
→ There are two techniques used for fiber Splicing.

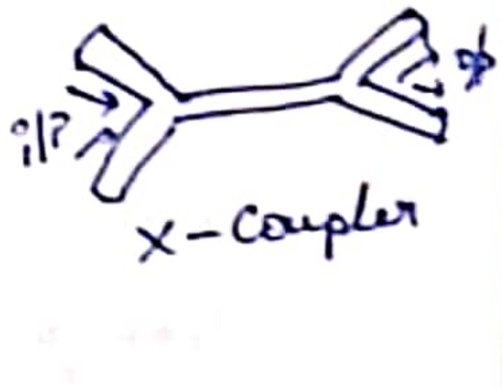
① Fusion Splicing (or) Welding Splicing
② Mechanical Splicing.

23) State the need of optical coupler / splitter :-

→ An optical coupler is a device that distributes light from a main fiber into one (or) more branch fibers (or) combine light signals from two & more fibers into single fiber.







→ They have very low loss
→ local monitoring of a light source output
→ also useful in fiber interferometers, also for combining two inputs.

24) List two types of sources used in OFC :-

The two types of sources used in OFC are :-

① LED (Light emitting diode)
② LASER (Light Amplification by stimulated emission of radiation)

2.5) List the salient features of an optical source :-

→ optical source's size and configuration must be best with launching light into an optical fiber.
→ Must accurately track the input signal to minimize distortion and noise
→ It should emit light at wavelengths where the fiber has low losses and low dispersion.
→ It must be capable of maintaining a stable output which is unaffected by changes in temperature etc.
→ It should be cheap
→ It should be highly reliable.

2.6) List two types of detectors used in OFC :-

Two types of detectors used in OFC are:-

① PIN diode

② Avalanche photo Diode (APD).

2.7) List the salient features of an optical detector :-

→ Its size should be suitable for efficient coupling and packaging.

→ It should have low noise distribution

→ It should maintain stable operation

→ It should have high Responsivity

→ It should have low response time

→ It should have high quantum efficiency.

2.8) State the principle of LASER :-

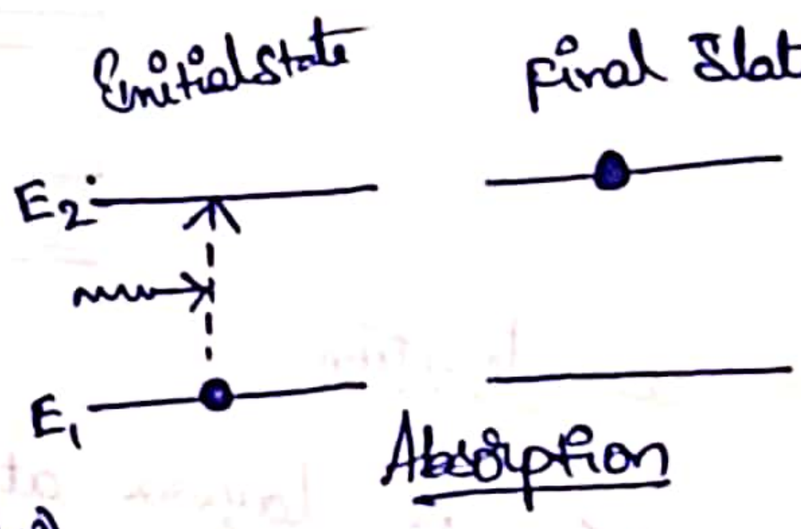
→ LASER stands for "Light Amplification by stimulated emission of Radiation".

→ LASER is a device that generates light by a process called Stimulated emission. Thus LASER works on the principle of "Stimulated emission".

① Absorption :-

→ Let us consider an electron in lower energy state E_1.

→ When a photon with energy ($E_2 - E_2 = h\nu$) is incident on an atom, then it moves from lower energy state to higher energy state through absorption of photon

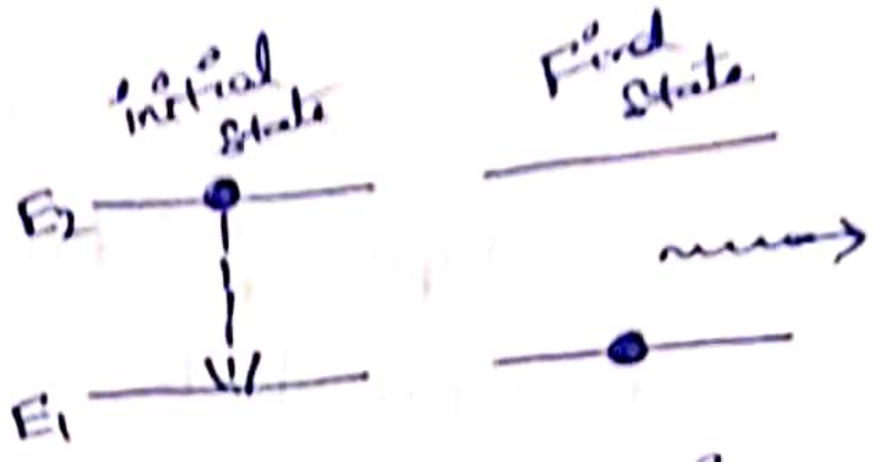


Absorption

(b) Spontaneous emission:

→ When the atom is initially in higher energy state E_2, it will be unstable.

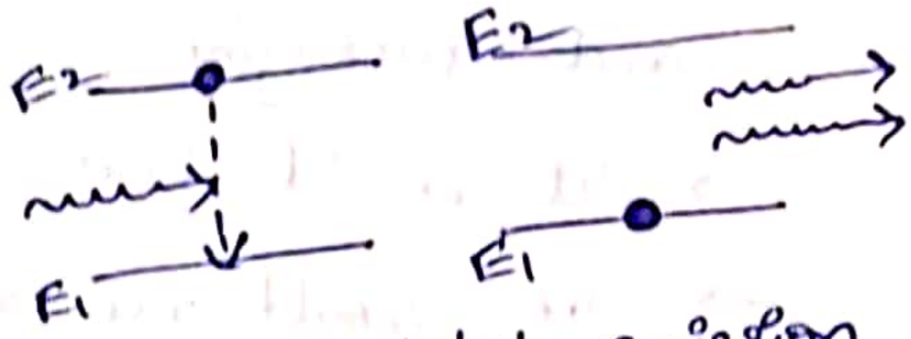
→ So it moves to lower energy state E_1 by emitting a photon. This process is called as spontaneous emission.



Spontaneous Emission

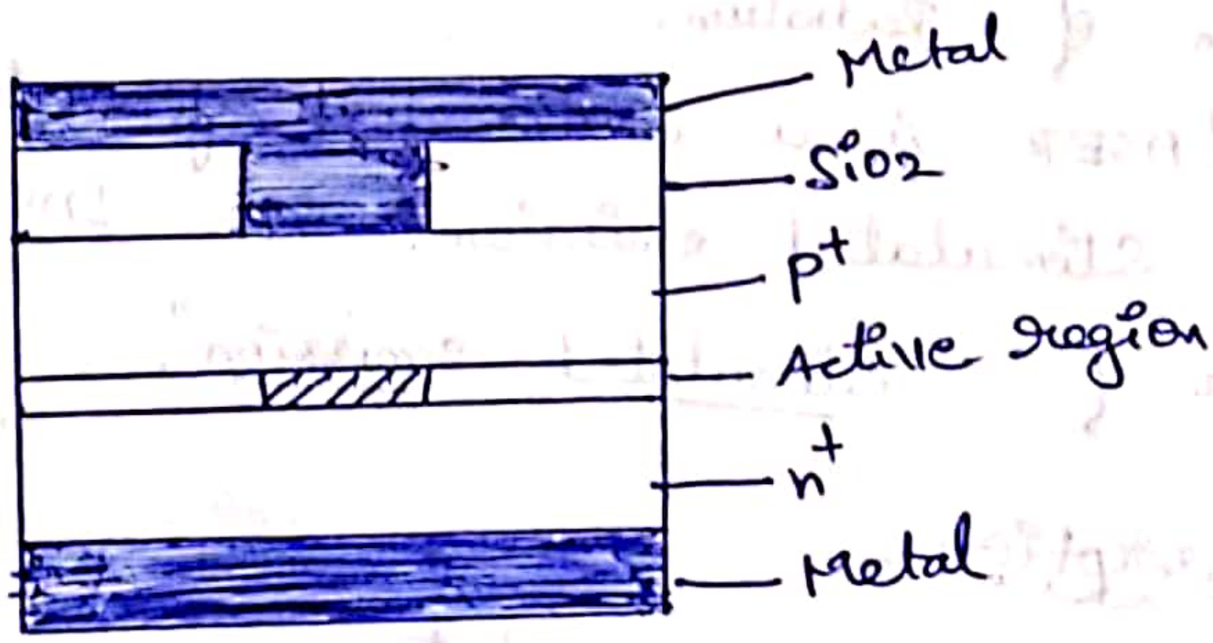
(c) Stimulated emission:-

→ When a photon with energy ($E_2 - E_1 = h\nu$) interacts with electron in higher energy state (E_2), then it causes that electron to retion to lower state by emitting two photons. This is called Stimulated emission.



Stimulated Emission

2.9) Explain the construction and working of LASER Source?



construction:-

→ The layers at PN-Junction are positioned in such a way that an active region is formed

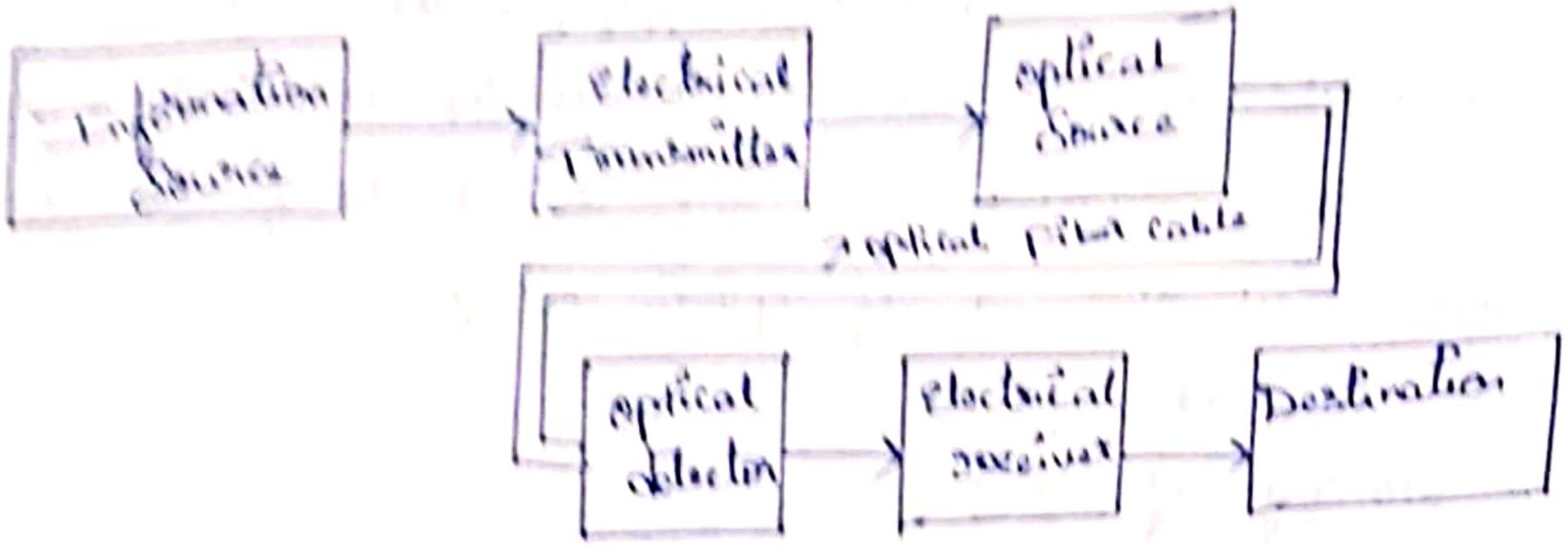
→ This region is responsible for generation of photons using recombination process.

→ In order to provide Supply to the laser diode, a metal layer is available on the top and bottom layers.
→ Semi-conductor sides are sliced to function as mirrors at the end of optical cavity.
→ the width of s
Working of Laser
→ principle of Laser (refer 2.8)
→ on Application of external voltage to the metal contacts present above and below the Semi-conductor layers, the current is passed through the forward biased PN-junction diode
→ Due to this, the holes present in p-region and electrons present in N-region will move to opposite regions.
→ By the recombination process in the active region, photons are emitted
→ Because of this phenomenon, a Stimulated radiation pattern is obtained.

2.10) Draw the Block diagram of Fibre optic communication System and explain each block?

The elements of optical communication System are,

① Information Source: The Source provides information in the form of electrical Signal to the Transmitter. The information may be audio, Video etc.



Block diagram of FOC System

① Electrical Transmitter :-

It transmits electrical signal from information source to optical source.

② optical Source :-

→ the optical source converts electrical signal to optical signal. The optical source's output is a light which is intensity modulated by the information

→ Source may be LED or LASER

③ optical fiber cable :

It acts as a transmission medium between transmitter and receiver and is made up of glass/plastic

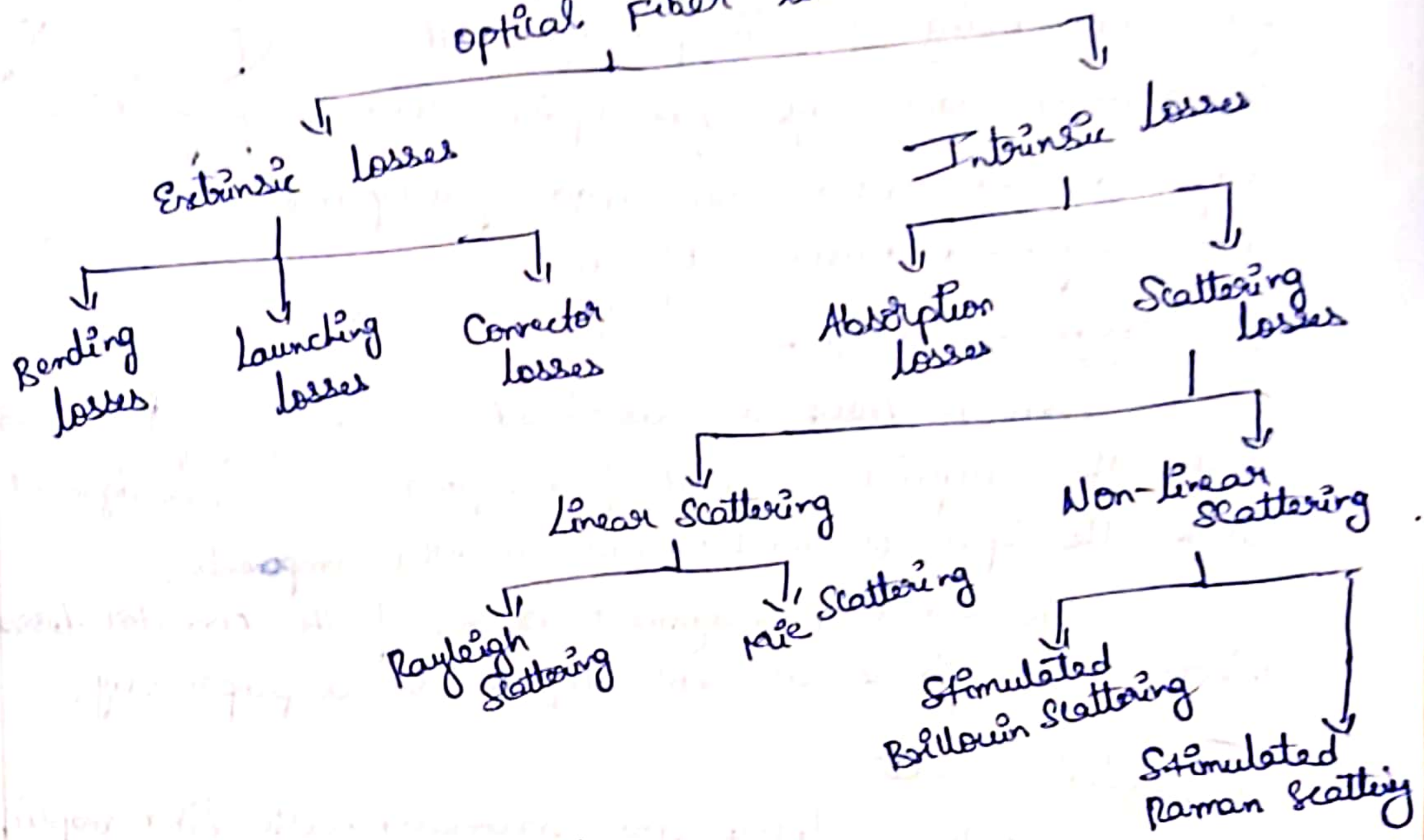
④ photo Detector :

→ It converts an optical signal into an electrical signal and gives to receiver Stage

→ photo detectors may be PIN diode (or) APD

⑤ Electrical receiver : Finally this Stage gets the real information back and gives it to destination.

2.11) Explain Intrinsic and Extrinsic losses in optical fibers?



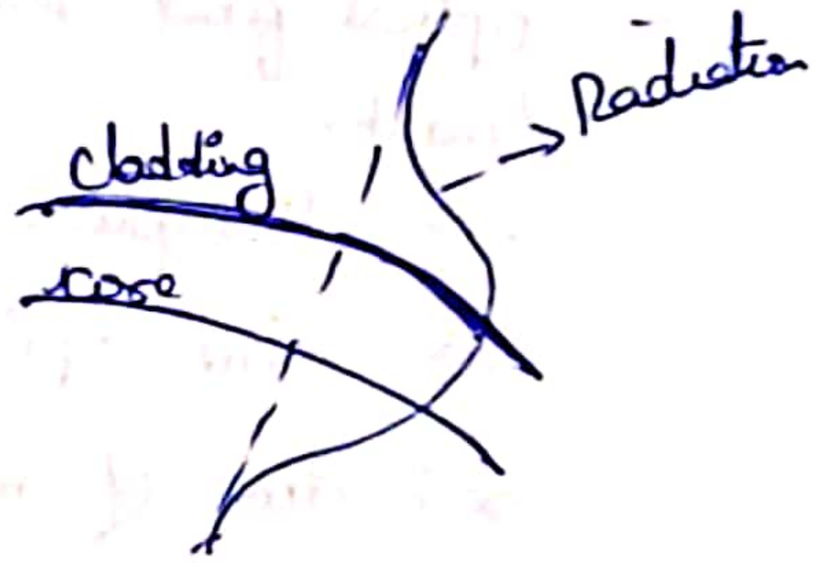
Intrinsic and Extrinsic losses:

Extrinsic losses: These losses are specific to geometry and handling of the fibers and are not functions of the fiber material.

There are 3 basic types:

1) Bending losses:

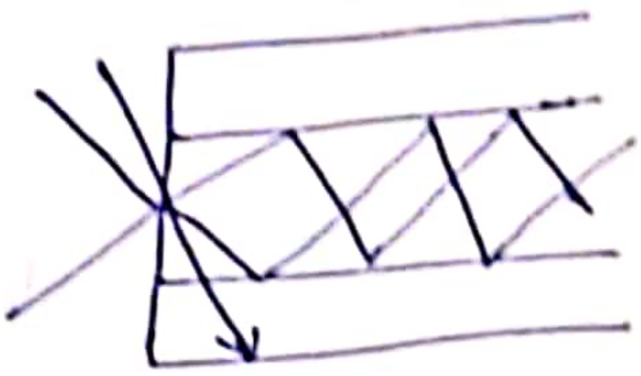
The loss which exists when an optical fiber undergoes bending is called as Bending losses.



losses :-

② Launching losses :-

This loss refers to an optical fiber not being able to propagate all the incoming light rays from optical source. Rays launched outside the angle of acceptance are refracted outside of fiber.



③ connector losses :-

connector losses are associated with the coupling of output of one fiber with the input of another fibre & other components.

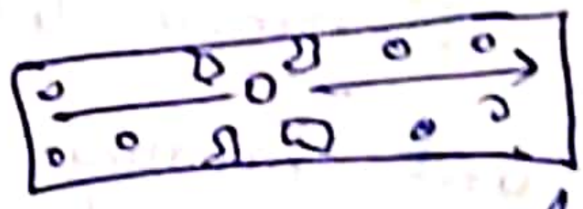
The lateral misalignment is one of the connector losses, where two fibers are not aligned in a proper way.

Intrinsic losses :-

Intrinsic losses are associated with fiber optic material itself and total loss is proportional to length L.

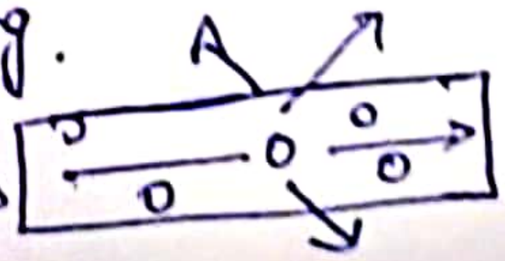
1) Absorption loss :-

→ Light loss through absorption in an optical fiber tends to exponential function of Absorption loss length.



→ Absorption loss is caused due to the presence of impurities
→ Thus optical power signal is reduced due to excitation of molecular vibrations of impurities.

2) Scattering loss :- power losses due to Scattering are caused by imperfections in core material and irregularities between junction and cladding.



2. Scattering loss mainly is of 2 types:-

① Linear Scattering.

→ In linear Scattering, there is no frequency change

→ this Scattering causes the transfer of optical power contained within one propagation mode to different mode linearly.

→ this is of 2 types:- ① Rayleigh Scattering
② Mie Scattering

② Non-linear Scattering:-

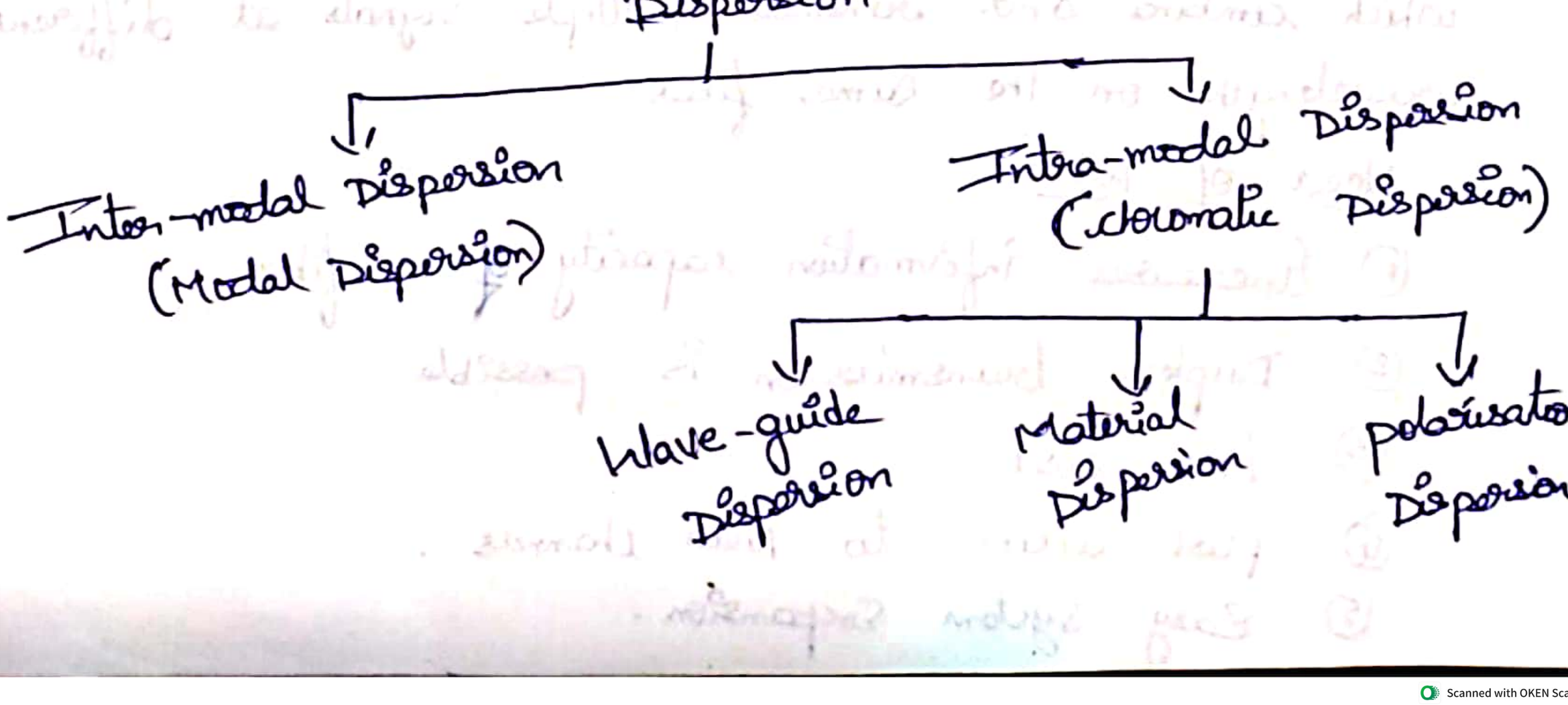
→ In Non-linear Scattering, there is a frequency change

→ this Scattering causes the optical power from one mode to be transferred in either forward or backward direction to the same mode or other modes at different frequency.

→ this is of 2 types:- ① Stimulated Brillouin Scattering
② Stimulated Raman Scattering.

2.12) classify different Types of Dispersions losses occur in optical fibers

Dispersion:- the Spreading of light pulse with time is called as Dispersion.



→ Multiplexing:- It is a process of sending multiple signals over a communication channel at the same time in the form of a single complex signal.

→ De-multiplexing:- At the receiver, these multiple signals are separated by a process called Demultiplexing.

2.13) State the Limitations of TDM in fiber optic communication

TDM:- Time Division Multiplexing is a technique where several optical signals are combined, transmitted together and separated based on arrival times.

→ It is a technique operating on time domain.

Limitations of TDM:-

① TDM require Synchronization between transmitter and receiver

② Difficult to maintain synchronization at a rate of 100 GbPS & above

③ It is not suitable for continous signals.

2.14) State the Need of WDM in fibre optic communication:

WDM:- Wavelength Division multiplexing is a technology which combine and transmits multiple signals at different wavelengths on the same fiber.

Need of WDM:-

① Increases information capacity of a fiber

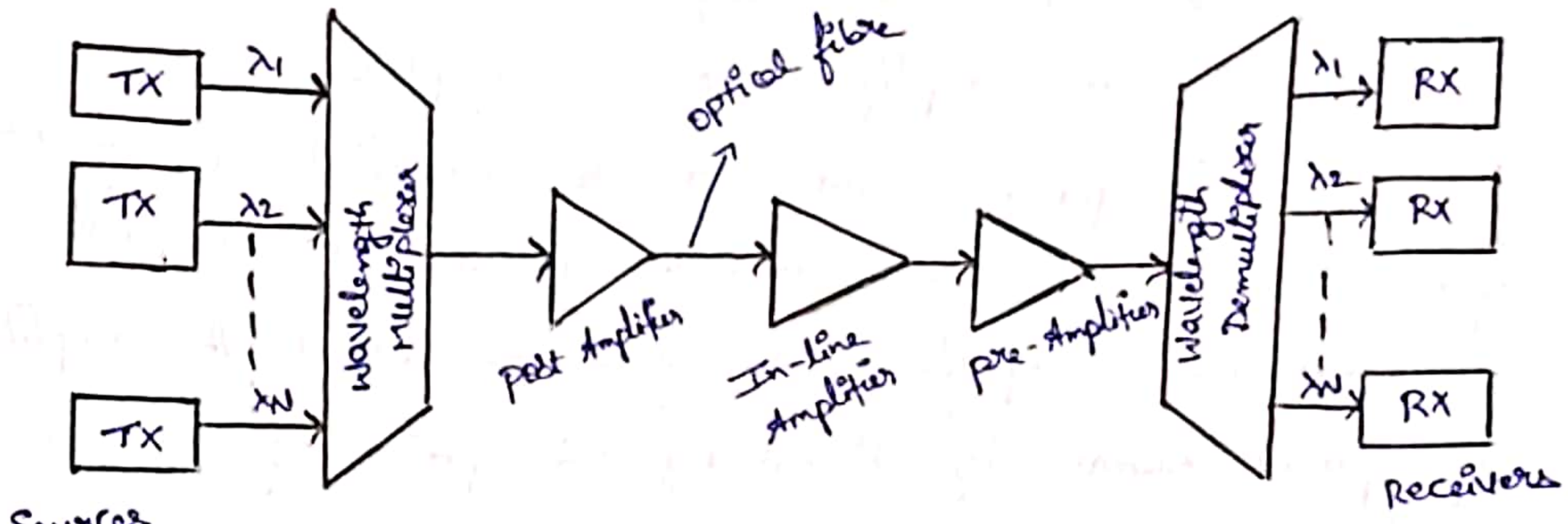
② Duplex transmission is possible

③ Low cost

④ Fast access to New channels.

⑤ Easy System Expansion.

2.15) Draw the block diagram of WDM System and explain?



Block diagram of WDM

Wavelength Division Multiplexing (WDM) is a technology which combines and transmits multiple signals at different wavelengths on the same fiber.

It consists of following components:-

① Transmitters / Receivers

→ WDM Transmitters consist of number of individual lasers with different wavelengths. These are used to create individual channels of WDM System.

→ A physical layer device is used to convert the incoming electrical signal to light signal & propagate through the fiber.

→ At the receiver end, the light signal is converted to electrical signal.

② Wavelength multiplexer / De-multiplexer:-

→ Multiple wavelengths are combined to be transmitted on fiber and these form a composite signal.

→ At the receiver end, this composite signal is again separated into individual wavelengths using De-multiplexer.

③ Amplifiers :-

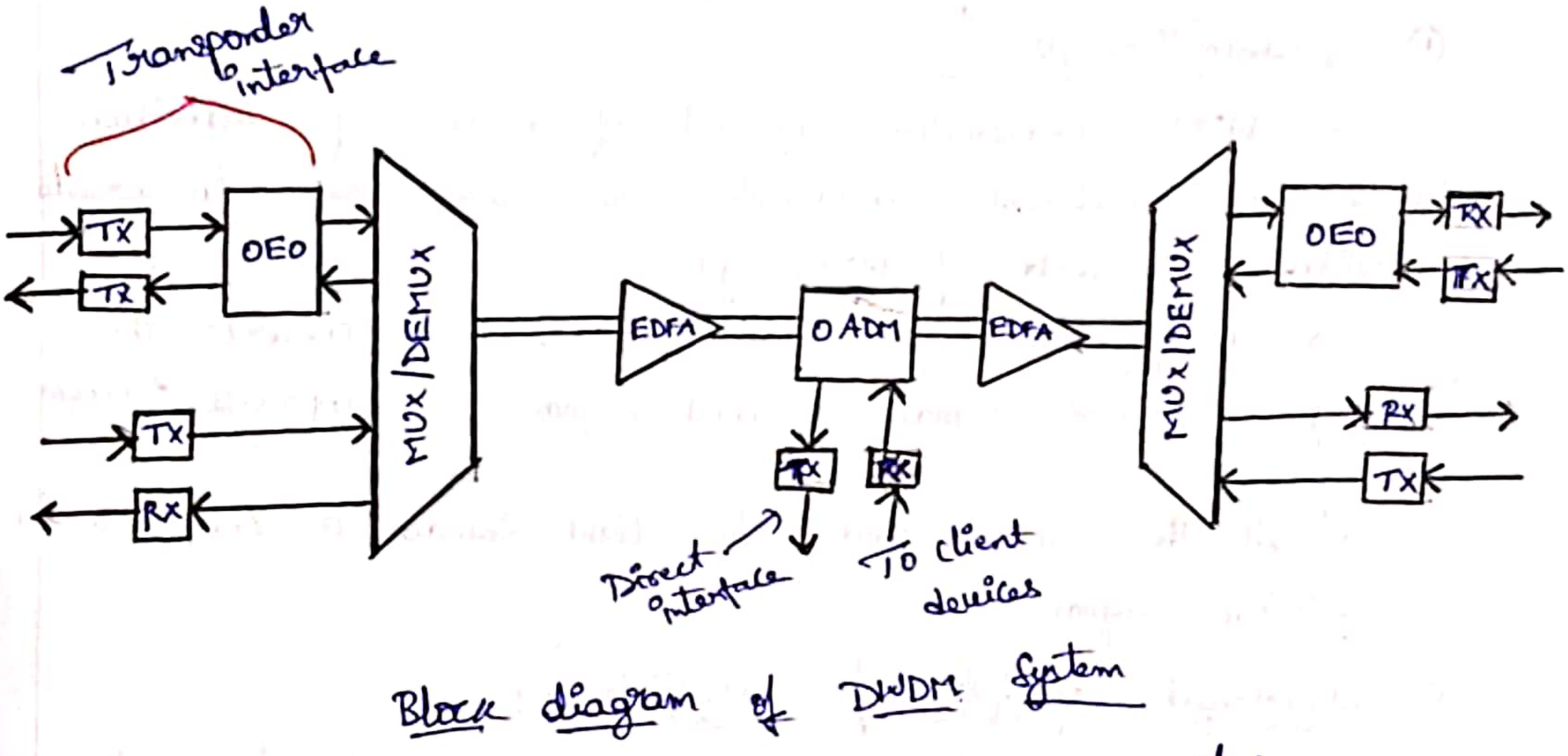
→ There are three amplifiers used in WDM i.e, post Amplifier, In-line Amplifier and pre-Amplifier

→ the optical signal can be amplified directly using optical Amplifiers without converting it to electrical signal.

→ These Amplifiers add gain (or) boost the amplitude of optical signal by stimulating the photons of signal with extra energy.

2.16) Draw the Block diagram of DWDM & explain?

DWDM (Dense Wavelength Division multiplexing) :-



Block diagram of DWDM System

→ DWDM System consists of following components :-

① optical Transmitters / Receivers
② DWDM MUX/DEMUX ,
③ optical Add / Drop multiplexers (OADM)
④ optical Amplifiers
⑤ Transponder (wavelength converter).

① Transmitters / receivers :-

→ DWDM transmitters consist of a large number of individual lasers with different wavelengths. These are used to create individual channels of DWDM system.

→ A physical layer device is used to convert the incoming electrical signal to light signal and propagate through the fiber.

→ At the receiver end, the light signal is converted to the electrical signal.

② DWDM Multiplexer / De-multiplexer :-

→ Multiple wavelengths are combined to be transmitted on one fiber and these form a composite signal

→ At the receiver end, this composite signal is again separated into individual wavelengths using de-multiplexer.

③ optical Add/Drop multiplexer (OADM) :-

→ OADM is designed to add or drop signals with particular wavelengths

→ ADD means the capability of a device to add new wavelength channel to the existing multi wavelength signal.

→ Drop means to remove channel passing signal to another path.

④ optical Amplifier (EDFA) :-

→ The optical signal can be amplified directly using optical amplifiers without converting it to electrical signal.

→ These amplifiers add gain (or) boost the amplitude of optical signals by stimulating the photons of signal with extra energy.

⑤ Transponder (wavelength converter) :-

→ Transponder is a device that is used to send and receive signals from fiber. These are used to convert full duplex electrical signal to full duplex optical signal.

→ These convert optical signal of one wavelength to optical signal of another wavelength suitable for DWDM applications.

→ These are also known as optical-electrical-optical (OEO) wavelength converters.