IQRA NATIONAL UNIVERSITY PESH.

Sessional Assignment #01

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Programe : Optical Communication

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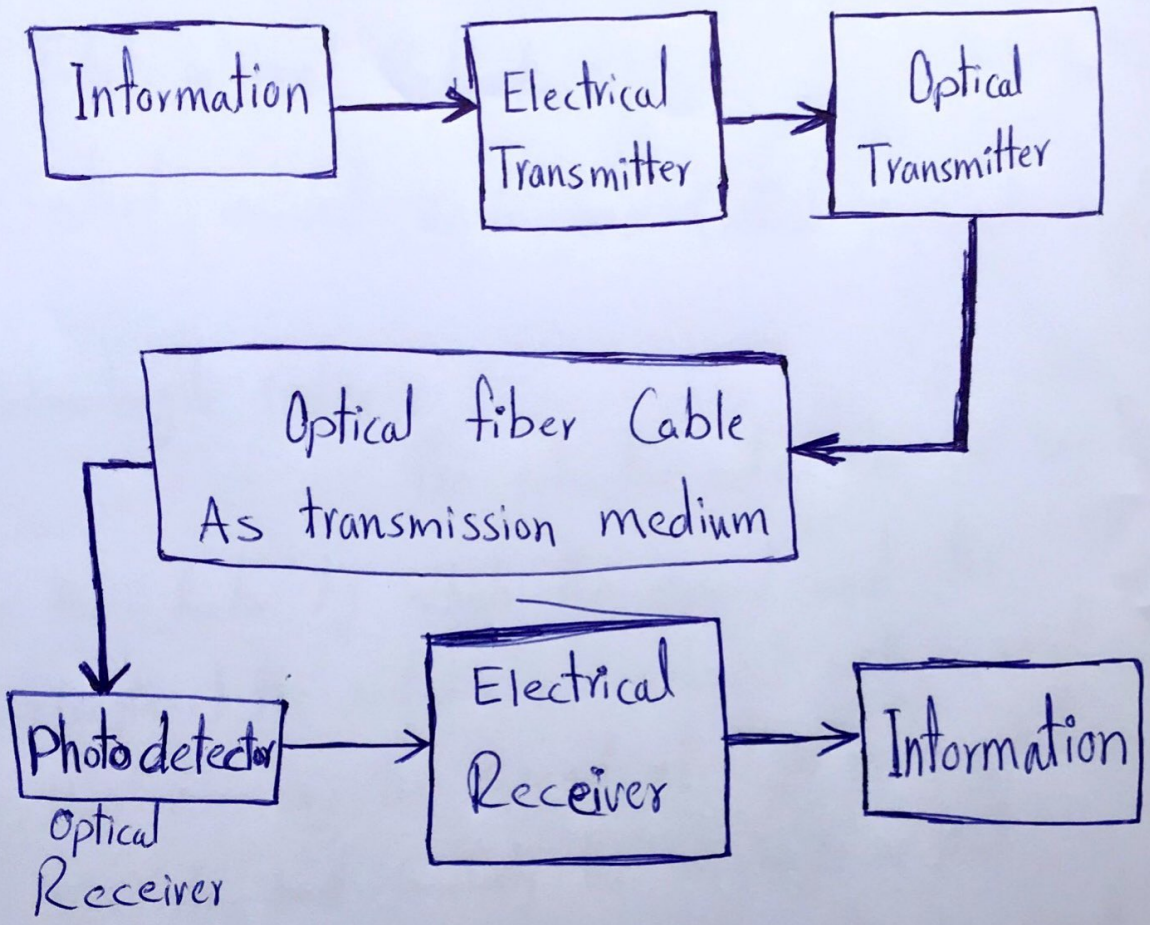
Q1:- What are the basic blocks of fiber optic Communication Systems, Explain it.

Ans:-



⇒ The Optical transmitter Consists of driver Circuit, light Source and fiber flylead.
Driver Circuit derives the light Source.
Light Source Converts electrical Signal to optical Signal. fiber flylead is used to Connect optical Signal to Optical fiber.

Q2:- Define the following

- Wavelength index
- Refractive index
- Total internal Reflection
- Critical incident angle and Critical propagation angle.

Ans:-

⇒ **Wavelength index:**

The refractive index can be seen as the factor by which the speed and the wavelength of the radiation are reduced with respect to their vaccum: the speed of light in a medium is $v = c/n$, and similarly the wavelength in that medium is $\lambda = \lambda_0/n$, where λ_0 is the wavelength of that light in vaccum.

⇒ **Refrative index:**

The refractive index of a material is a dimensionless number that describes how fast light travels through the material. It is defined as. where c is the speed of light in vaccum and v is the phase velocity of light in the medium.

⇒ Total Internal Reflection:

When light travels from a medium with a higher refractive index to a medium with a lower refractive index and it strikes the boundary at more than the critical incident angle, all light will be reflected back to the incident medium it will not penetrate the second medium.
This phenomenon is called total internal reflection.

⇒ Critical Incident angle:

The incident angle it which the angle of refraction equals 90° is called the critical incident angle.

⇒ Critical Propagation Angle:-

The critical propagation Angle, α_c, represents the requirement to achive this condition.
In Conclusion, then, to Save light inside an optical fiber, it is necessary to direct rays at this Critical ~~angle~~ propagation angle - or even at a ~~least~~ lesser angle.

Q4 :- Calculate the maximum transmission distance for a fiber link with an attenuation of 0.4 dB/km if the power launched is 1mw and the receiver sensitivity is 40 μw?

Ans :-

Solution :

Just plug the numbers into formula

$$L = (10/A)\ Log_{10}\ (P_{in}/P_{out})$$

$$L_{max}\ (km) = (10/A)\ log_{10}\ (P_{in}/P_{out})$$

$$L_{max}\ (km) = (10/0.4)\ log_{10}\ (22) =$$

$$L_{max}(km) = 17.629\ km$$

Q6 :- What is chromatic Dispersion? Explain the types of chromatic Dispersion occur in the single mode fiber.

Ans :- Chromatic Dispersion :-

Is a phenomenon that is an important factor in fiber optic Communications. It is the result of the different Colors, or wavelengths, in a light beam arriving at their destination at slightly different times.

⇒ Types occur in the Single mode fiber :-

There are three types of dispersion, chromatic, model, and material.

Chromatic dispersion results from the Spectral width of the emitter.

The Spectral width determines the number of different wavelengths that are emitted from the LED or laser.

Q7 :- Define the following terms

⇒ Transparent Window ⇒ Mode field Diameter

⇒ Polarization Mode Dispersion

⇒ Intermodal Dispersion

Ans :-

⇒ Transparent window :-

Let the operating System's desktop show through, while opaque windows obscure the desktop area behind them...

A window that uses System Chreme is always opaque.

⇒ Mode field Diameter :-

In fiber optics, the media field diameter is an expression of distribution of the radiance. i,e the optical power Per unit area, across the end face of a Single mode fiber.

⇒ Polarization mode dispersion :

Polarization mode dispersion is a form of modal dispersion where two different Polarizations of light in a waveguide, which normally travel at the same speed, travel at ~~the same~~ different speed due to random imperfections and asymetries, causing random spreading of optical pulses.

⇒ Inter Model Dispersion :

Inter modal dispersion (also called modal dispersion) is the phenomenon that the group velocity of light propagating in a multimode fiber (or other waveguide) depends not only on the optical frequency (→ propagation mode involved.

Q8 :- Calculate Pulse Spread Caused by polarization mode dispersion of $D_{PMD} = 0.4\ Ps/\sqrt{km}$ and $L = 200\ km$?

Ans :- Pulse Spread Caused by Polarization mode dispersion

Solution :- If $D_{PMD} = 0.4\ Ps/\sqrt{km}$

and length $L = 200\ km$

As ΔT Caused by PMD is proportional to $\sqrt{L}$.

$$D_{PMD} = 0.4\ Ps/\sqrt{200}$$

$$D_{PMD} = \frac{0.4\ Ps}{14.14} = 0.0283$$

$$\boxed{D_{PMD} = 0.0283}$$

Q9 :- A Single mode fiber has the following Parameters : Core diameter (d) = 7.3 μm, Core refractive index (n_1) = 1.4692 and relative index (Δ) = 0.36 %.
Calculate the V- number at the 1500 nm Operating wavelength.

Ans :-

⇒ No. of modes supported by optical fiber is obtained by cut-off Condition known as normalized frequency or V- Number.

⇒ Number of modes (N) = $\frac{1}{2} V^2$

⇒ V-number Can be reduced either by reducing numerical aperture or by reducing diameter of fiber.

$$V = \frac{2\pi a}{\lambda}\sqrt{n_1^2 - n_2^2} = \frac{2\pi a}{\lambda} NA,$$

This is an important parameter of optical fiber given by the relation.

$$V = \frac{2\pi a}{\lambda}\sqrt{M^2_{core} - M^2_{clad}}$$

Where a is the radius of the Core and λ is free space wave length.

Q9

The maximum number of modes (N_m) Supported by a Single mode step index fiber is determined by.

$$N_m = \frac{1}{2} V^2$$

If $V < 2.405$, the fiber will support only one mode and known as single mode optical fiber.

If $V > 2.405$, the fiber will support many modes Simultaneously.

This is known as multi-mode fibre.

The wavelength corresponding to the value $V = 2.0405$ known as cutoff wavelength this is expressed as

$$\lambda_c = \frac{\lambda V}{2.405}$$