FIBRE OPTICS [redacted]

PHYSICS

5 NO 33

Topics

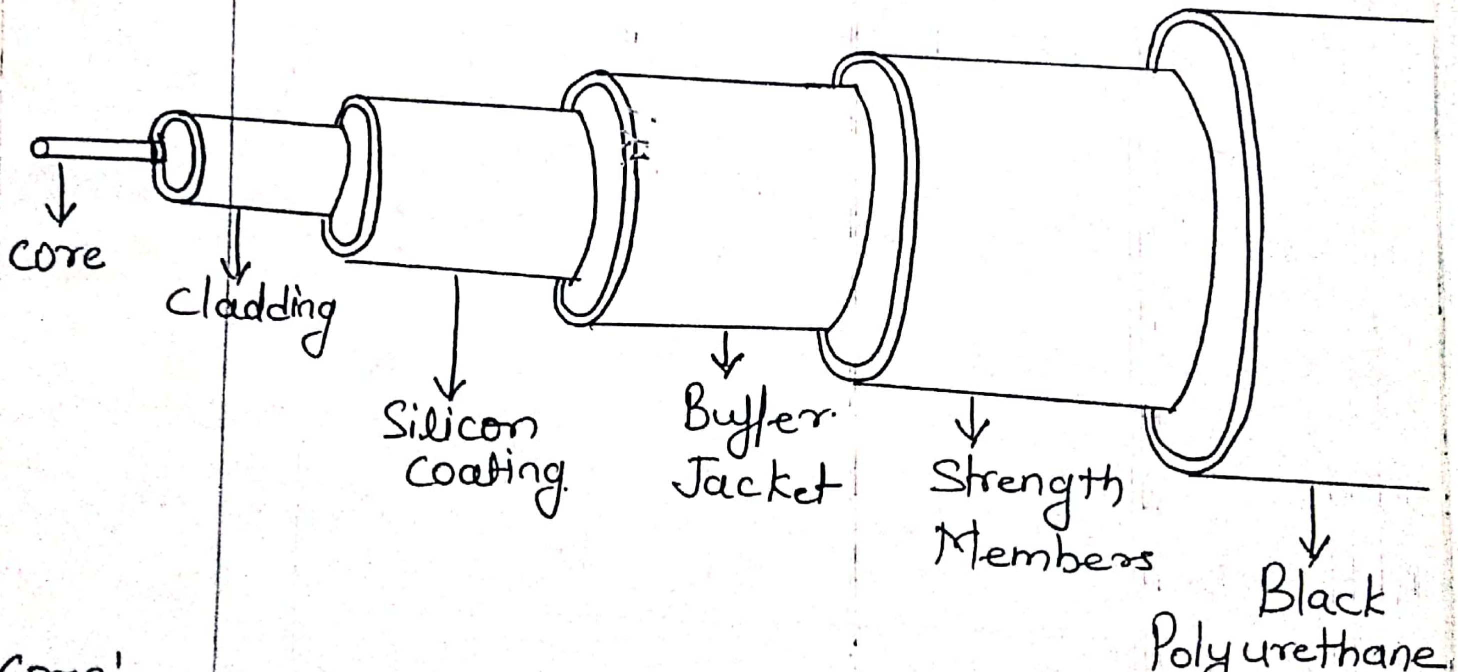
→ Introduction
→ Basic theory
→ Acceptance Angle
→ Numerical Aperture
→ Normalized frequency etc.
→ Modes of Propagation
→ Material Dispersion & Pulse dispersion in optical fibre
→ fibre connectors & Couplers
→ Application of Optical fibre

Optical fibre:- Optical fibre are very thin glass or plastic fibre in which light signals can travel over a long distance without degrading the signals

Structure of Optical fibre:-

Optical fibre consist three Sections

→ Core
→ Cladding
→ Buffer Jacket



→ **Core:-** The innermost layer is called Core where light signals can travel. It has higher Refractive Index than surrounding, so act as denser medium

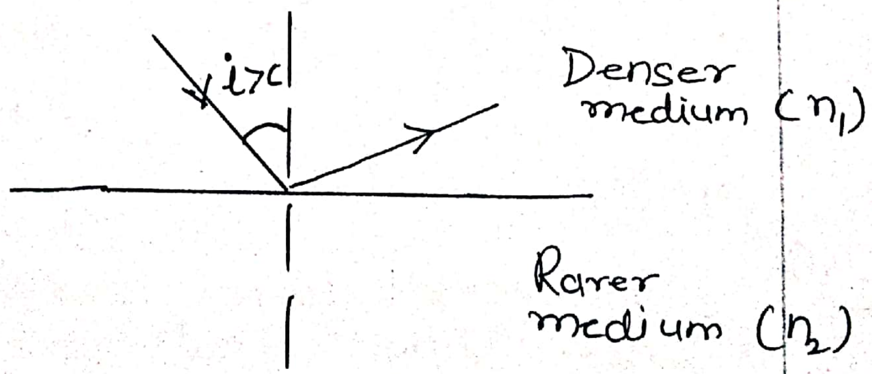
→ **cladding:-** fibre core is surrounding by thin transparent sheat Called cladding. Refractive index of cladding is always lower than core. So act as rarer medium, thus T.I.R takes place at core-cladding Boundary.

<u>Silicon Coating</u>:- It protects the cladding from moisture & impurities present in Surrounding & also provide mechanical Strength to Core.

→ with Buffer Jacket, Strength members, Black Polyurethane Jacket installation & handling of fibre become easier.

Basic Principle:- (TIR)

When light signals travels from denser medium to rarer medium, at a particular angle of incidence called Critical angle, the ray gets refracted through 90°. This refracted ray is called gazing ray. If angle of incidence is greater than Critical angle, the ray gets totally internally reflected back.



<u>$i > c$</u>

Thus Condition for TIR for optical fibre

→ Refractive index of Core is always greater than Cladding

→ light Should be incident on axis of fibre at an angle greater than critical angle using Snell's law

$$\frac{\sin i}{\sin r} = \frac{n_2}{n_1}$$

when $i = c$ & $r = 90°$

$$\frac{\sin c}{\sin 90°} = \frac{n_2}{n_1}$$

$$\sin c = \frac{n_2}{n_1}$$

$$c = \sin^{-1}\left(\frac{n_2}{n_1}\right)$$

Hence, when light travels from denser to rarer medium, at a particular angle called critical angle, ray get refracted with angle 90°. If angle of incidence is greater than critical angle the ray get totally reflected back in same medium.

Selection of fibre Material

1. It should be possible to draw long thin flexible wires from the material
2. For core-cladding, there should be slightly difference in their refractive index.
3. Material must be transparent at a particular optical wavelength.

According to wavelength of light rays passes through optical fibre, material of optical fibre will be decided i.e. Mainly, There are three types of fibre made.

1) Plastic core with Plastic cladding.
2) Glass Core with Plastic cladding.
3) Glass core with Glass cladding.

Fractional Refractive Index Difference

Let n_1 = refractive Index of Core
n_2 = refractive Index of cladding
where $n_1 > n_2$

So, fractional Refractive Index is denoted by Δ is,

$$\Delta = \frac{n_1 - n_2}{n_1}$$

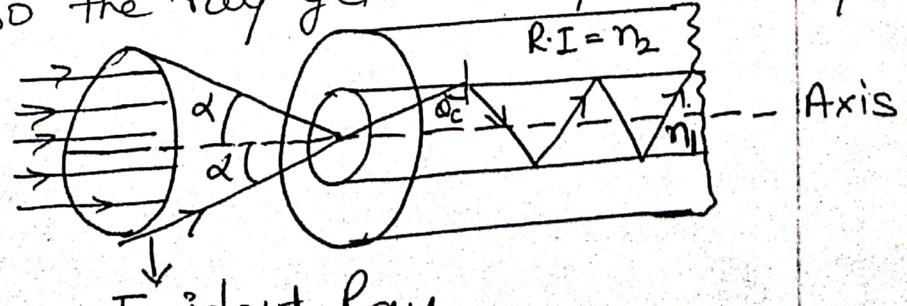
In Order to have effective Communication,

$$\Delta < 1$$

But Practically $\simeq 0.01$.

Acceptance Angle

If $\angle i > \theta_c$, So the ray gets totally internally reflected



Acceptance angle is defined as maxium angle that a light ray can have relative to the axis of fibre & Propagate down the fibre.

Acceptance Cone

It is the cone around the axis of core having angle $2\alpha_{Max}$, so that all the light signals which are incident within the cone are totally internally reflected at core cladding interface.

Numerical Aperture :- OR figure of Merit

Sine of maximum acceptance angle is called Numerical Aperture.

$$N.A = \sin \alpha_{max}$$

Physically it gives light gathering ability of the optical fibre.

Greater is the diameter of core, greater will be the light gathering ability, & Hence greater will be Numerical aperture

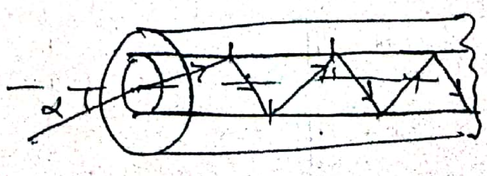
$$\boxed{N.A = \sin \alpha_{max} = \sqrt{n_1^2 - n_2^2}}$$

where n_1 = Refractive Index of core

n_2 = Refractive index of cladding

Total Number of Reflections

Total No. of Reflections for a given Signal in optical fibre are



$$\boxed{N = \frac{L \tan\theta}{a} - 1}$$

where a = radius of core

L = length of fibre

θ = angle made by light ray with normal to core cladd[ing]

Types of optical fibre

On the basis of propagation of light (modes)

Mode :- allowed path of light in optical fibre

So,

(1) On the basis of Modes of Propagation optical fibre are of two type

- Single Mode
- Multimode

→ **Single Mode optical fibre :-** In this, only one mode can propagate through the fibre

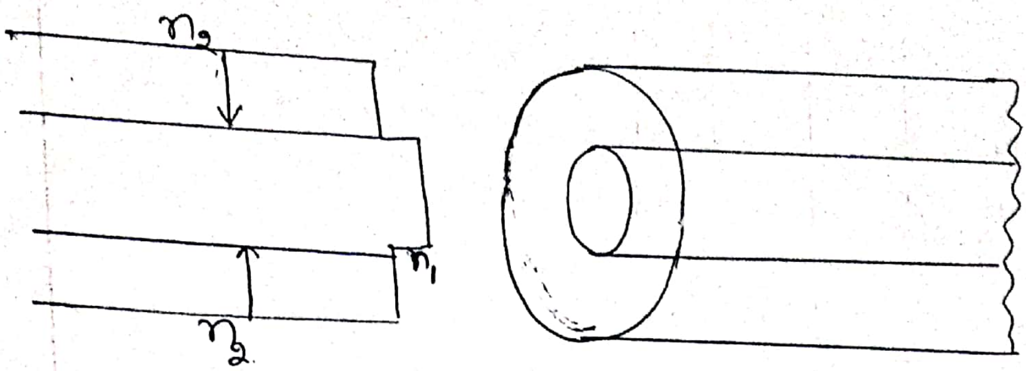
→ **MultiMode optical fibre :-** Multimode fibre allows a large number of modes for the light rays travelling through it.

(2) ON the basis of Core

- Step Index fibre
- Graded index fibre.

Step Index Optical fibre :- If the refractive index of Core is Constant throughout the Core region & it abruptly changes to the refractive index of cladding at core - cladding interface, then optical fibre is called Step Index optical fibre.

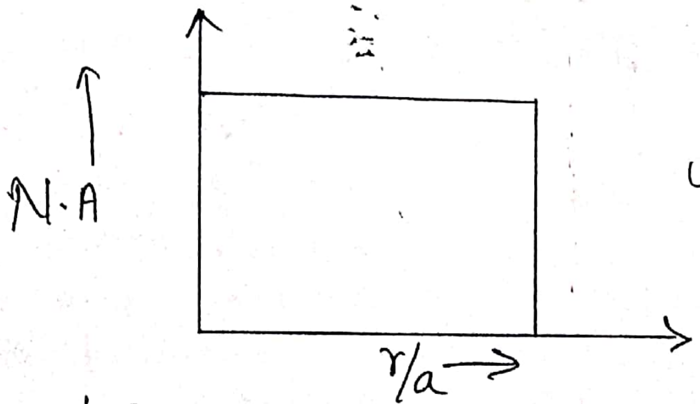
A



⇒ Numerical Aperture is constant through out core

$$N \cdot A = \sqrt{\frac{n_1^2 - n_2^2}{n_0^2}}$$

⇒ If we draw graph b/w Numerical aperture & r/a we get graph as shown below



where
r = any distance from centre of core

⇒ It can sustain both single as well as multimodes

⇒ Maximum Number of Modes are

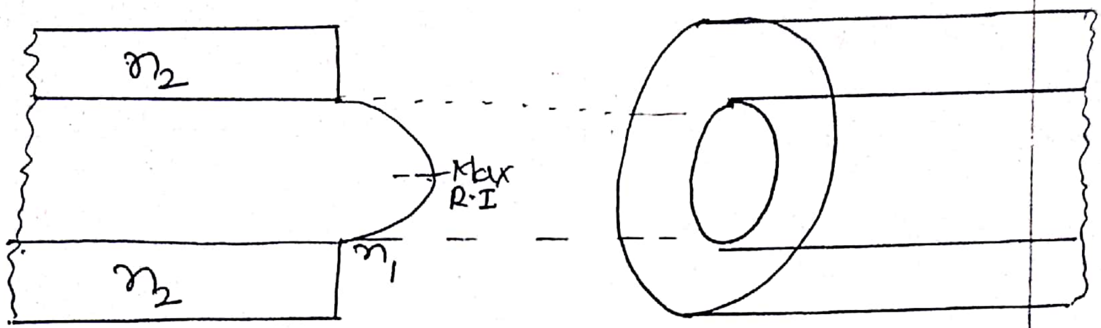
$$N_m = \frac{V^2}{2}$$ where V = normalized frequency

⇒ Step index fibre provide comparatively less band width than graded index optical fibre.

⇒ Rate of data transmission is less

Graded Index Optical Fibre

In this type of optical fibre core has non uniform refractive index i.e. maximum at centre & decreases prabalically on moving toward outeredge of core.



Refractive index of core at distance r from centre will be

$$n(r) = n_1\left[1 - 2\Delta\left(\frac{r}{a}\right)^{\alpha}\right]^{1/2}$$

where :-
n_1 = Refractive index of core
Δ = fractional R-I
r = any distance from centre of core
α = dimensionless constant

∴ when r = a (at core-cladding interface)

$$n(r) = n_1[1 - 2\Delta]^{1/2}$$

Now, using Binomial Theorm & neglecting higher Powers of Δ

$$n(r) = n_1\left[1 - \frac{1}{2} \times 2\Delta\right]$$

$$\boxed{n(r) = n_1[1 - \Delta]} \quad \text{——— (1)}$$

As we know

$$\Delta = \frac{n_1 - n_2}{n_1}$$

$$\Delta n_1 = n_1 - n_2$$

Now put the value of Δn_1 is Eq^n (1)

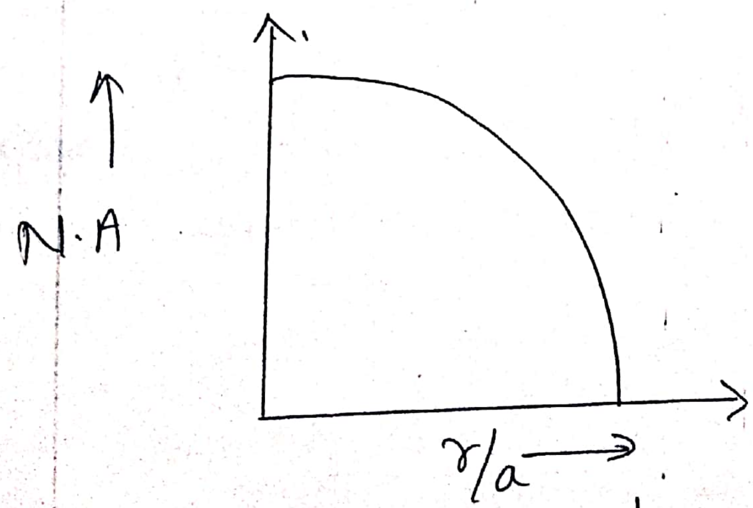
$$n(r) = \cancel{n_1} - \cancel{n_1} + n_2$$

$$\boxed{n(r) = n_2.}$$

⇒ Numerical Aperture will be.

$$N \cdot A = \sqrt{\frac{n(r)^2 - n_2^2}{n_0^2}}$$

⇒ The Graph b/w Numerical Aperture & r/a. in Graded index optical fibre will be

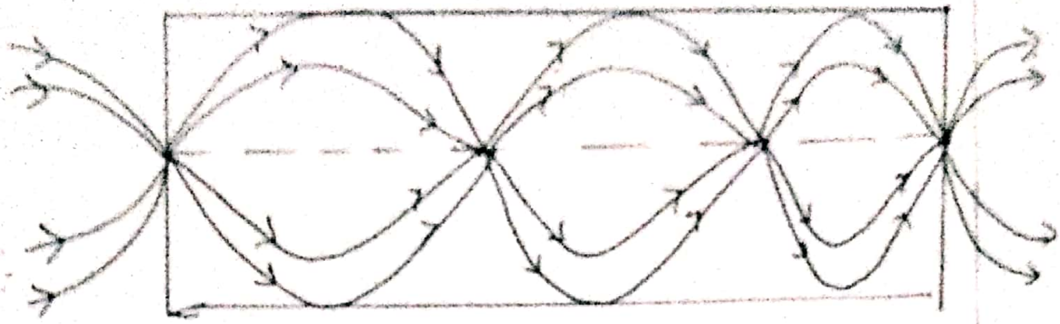


⇒ It sustain multimode only.

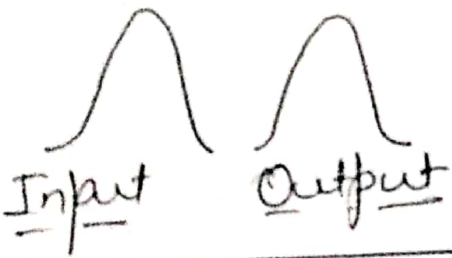
⇒ Maximum no. of modes are $N_m = \frac{V^2}{4}$

⇒ It provides much larger bandwidth as Compare to step Index optical fibre.

⇒ light rays follow helical path

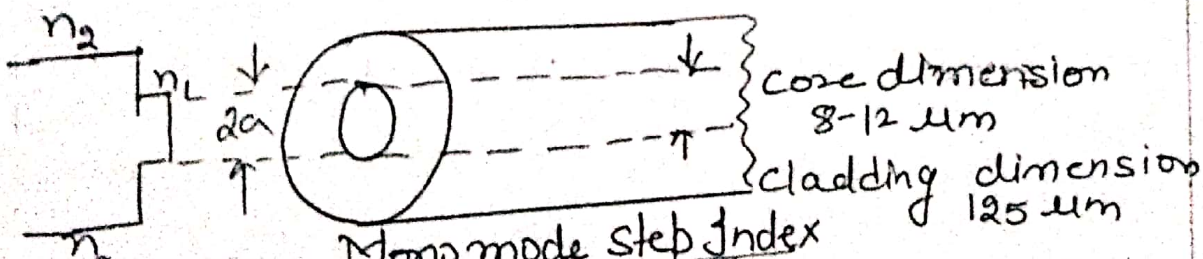


Graded Index OF

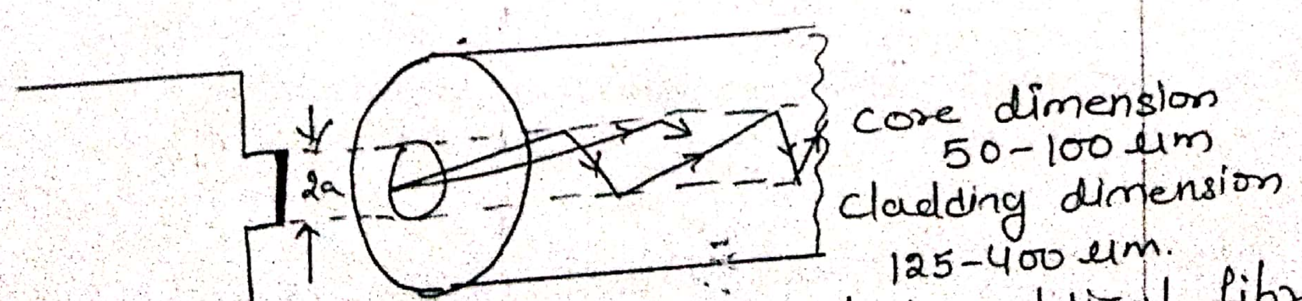


Qu why it is not possible to have graded index optical fibre as a single mode optical fibre?

Sol^n ⇒ Step Index optical fibre can be used as both single mode as well as multimode optical fibre depending upon dimension of core.

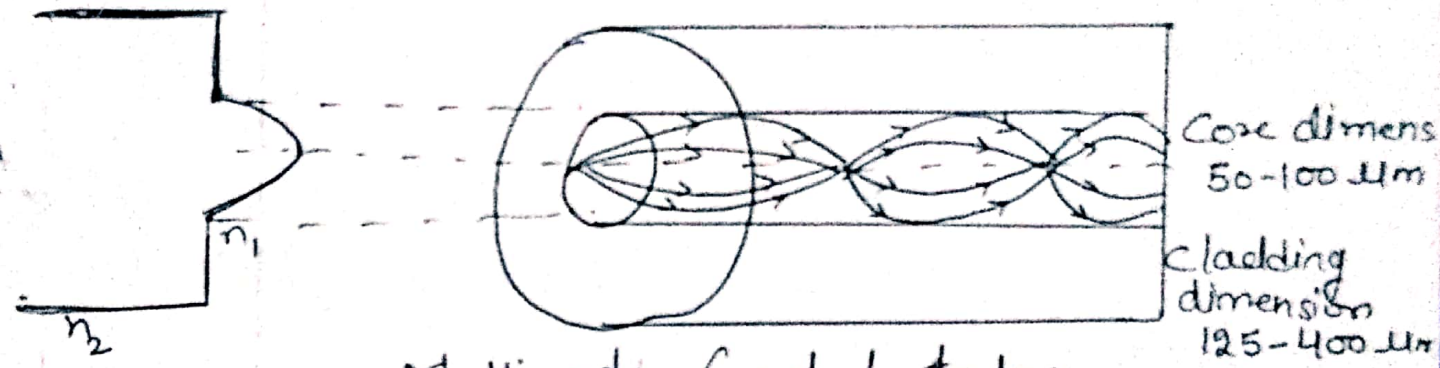


Mono mode Step Index fibre.



Multimode Step Index optical fibre

It is not possible to have graded index optical fibre as single mode optical fibre. because it not possible to fabricate core of varying refractive index of very small diameter practically. So that is why graded index optical fibres are only multimode optical fibre

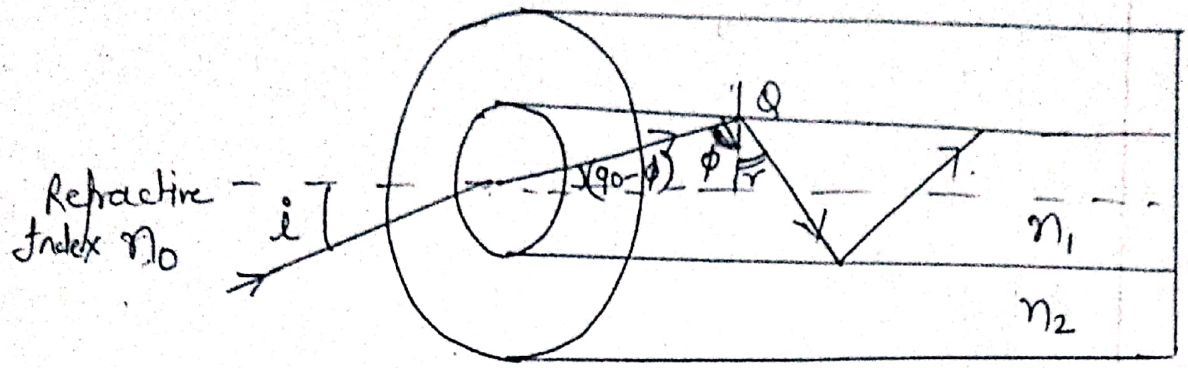


Multimode Graded Index optical fibre.

Expression for Acceptance Angle & Numerical Aperture

Let us consider beam of light enters at an angle i to the axis of core such that it makes angle ϕ with normal at core cladding interface. For propagation of light signal in optical fibre ϕ must be greater than critical angle c.

Let n_1 = Refractive index of Core
n_2 = " " of cladding.
n_0 = Refractive index of Outside medium



Now, Applying Snell's law at launching region i.e. at Outside core

$$\frac{\sin i}{\sin(90-\phi)} = \frac{n_1}{n_0} \quad \text{——— (1)}$$

Now, Applying Snell's law at core-cladding interface i.e. at Q

$$\frac{\sin\phi}{\sin r} = \frac{n_2}{n_1} \quad \text{——— (2)}$$

Let α = maximum value of acceptance angle then

$$i = \alpha \;;\; \phi = c \;;\; r = 90°$$

So Eqn (1) becomes

$$\frac{\sin\alpha}{\sin(90-c)} = \frac{n_1}{n_0}$$

$$\frac{\sin\alpha}{\cos c} = \frac{n_1}{n_0}$$

$$\cos c = \frac{n_0}{n_1}\sin\alpha \quad \text{——— (3)}$$

& Eqn (2) becomes

$$\frac{\sin C}{\sin 90^\circ} = \frac{n_2}{n_1}$$

$$\sin C = \frac{n_2}{n_1} \quad \text{———— (4)}$$

Now, Squaring & adding Eq^n (3) & (4)

$$\cos^2 C + \sin^2 C = \frac{n_0^2}{n_1^2} \sin^2\alpha + \frac{n_2^2}{n_1^2}$$

$$1 = \frac{n_0^2}{n_1^2} \sin^2\alpha + \frac{n_2^2}{n_1^2}$$

$$n_1^2 = n_0^2 \sin^2\alpha + n_2^2$$

$$n_1^2 - n_2^2 = n_0^2 \sin^2\alpha.$$

$$\frac{n_1^2 - n_2^2}{n_0^2} = \sin^2\alpha.$$

$$\boxed{\sin\alpha = \pm\sqrt{\frac{n_1^2 - n_2^2}{n_0^2}}}$$

Thus

Numerical Aperture

$$\boxed{N.A = \sqrt{\frac{n_1^2 - n_2^2}{n_0^2}}}$$

Maximum Acceptance angle.

$$\boxed{\alpha = \sin^{-1}\sqrt{\frac{n_1^2 - n_2^2}{n_0^2}}}$$

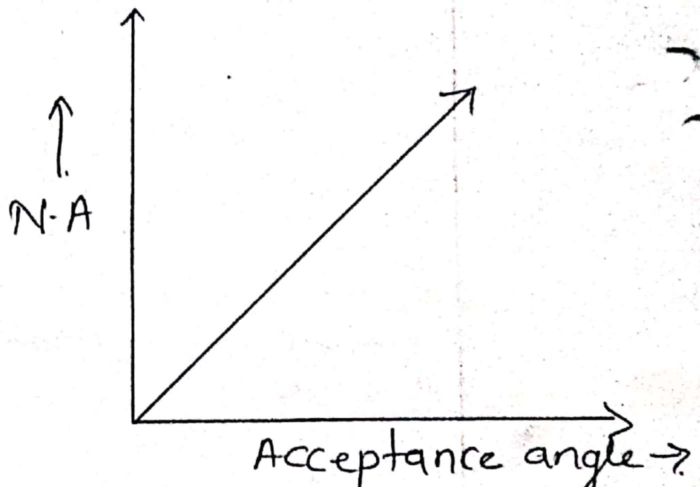
+ Angle of Acceptance cone i.e.

$$2\alpha = 2\sin^{-1}\sqrt{\frac{n_1^2 - n_0^2}{n_0^2}}$$

If launching medium is air so refractive index $n_0 = 1$ so numerical aperture will be.

$$N.A = \sqrt{n_1^2 - n_2^2}$$

Graph shows variation of N.A with acceptance angle.



Practically, for short distance communication N.A are in range 0.4 to 0.5, while for long distance communication N.A are in range from 0.1 to 0.3

But as smaller will be Numerical aperture it is difficult to launch the light rays in optical fibre.

Relation B/w Numerical Aperture & Fractional Refractive Index (Δ)

From definition of fractional Refractive index is

$$\Delta = \frac{n_1 - n_2}{n_1}$$

& Numerical Aperture is

$$N \cdot A = \sqrt{\frac{n_1^2 - n_2^2}{n_0^2}}$$

$$n_1^2 - n_2^2 = (n_1 + n_2)(n_1 - n_2)$$

Now; Multiply & divide by $2n_1$ in above Eq^n

$$n_1^2 - n_2^2 = \frac{(n_1 + n_2)}{2} \frac{(n_1 - n_2)}{n_1} \times 2n_1 \quad \left(\because \frac{n_1 - n_2}{n_1} = \Delta\right)$$

$$= \Delta \left(\frac{n_1 + n_2}{2}\right) 2n_1$$

as there is very slightly diff b/w. core & cladding R.I.

So; $n_1 \simeq n_2$ So above Eq^n becomes

$$n_1^2 - n_2^2 = \Delta \left(\frac{2n_1}{2}\right) 2n_1$$

$$n_1^2 - n_2^2 = 2\Delta n_1^2$$

or

$$\sqrt{\frac{n_1^2 - n_2^2}{n_0^2}} = \sqrt{\frac{2\Delta n_1^2}{n_0^2}}$$

{taking Square root both sides by divided both sides by n_0}

So;

$$\boxed{N \cdot A = \frac{n_1}{n_0}\sqrt{2\Delta}}$$

If $n_0 = 1$ {for air R.I = 1}

So;

$$\boxed{N \cdot A = n_1 \sqrt{2\Delta}}$$

Normalized frequency or V number

It is basically, a dimensionless quantity which tells about the type of optical fibre.

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

where a = radius of core.
λ = wavelength of incident light passing through O.F core.

(1) If $V < 2.405$ then O.F is Single Mode optical fibre.

(2) If $V > 2.405$ then O.F is Multimode optical fibre.

(3) If $V = 2.405$, then corresponding wavelength is called Cut off wavelength.

Signal Distortion in optical Waveguides or Dispersion in optical fibre

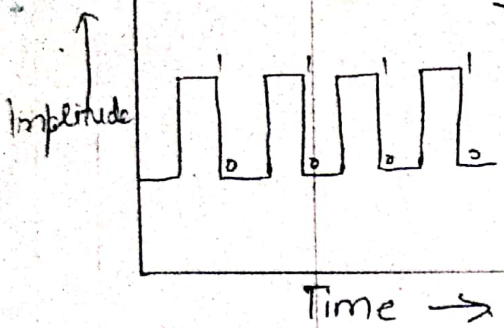
OR

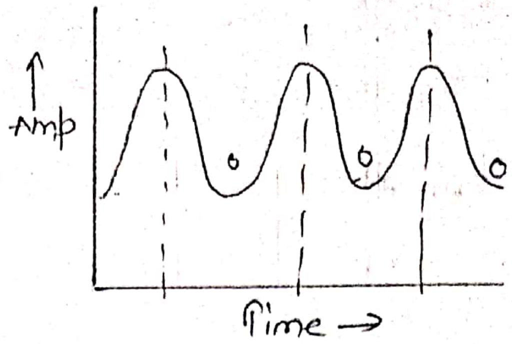
Pulse Dispersion.

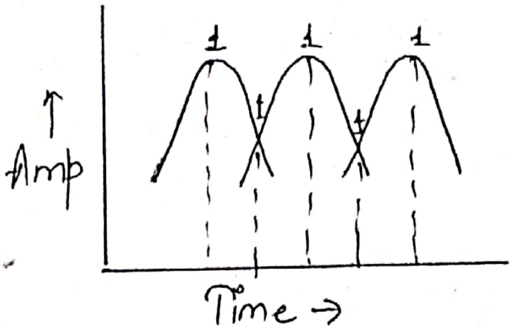
When light pulses passes through optical fibre, it suffers several dispersion effect. It causes spreading of output signals & changes its shape. Hence signals get distorted. are called Pulse dispersion.

Scanned by CamScanner

Input Pulse







Mixing of Output Pulse.

Output Pulse.

Pulse dispersion are of two types

Pulse Dispersion
- Intramodal
- Intermodal

(1) Intramodal Dispersion :- It is also known as chromatic dispersion. It occurs within a single mode optical fibre only. It depends on wavelength. therefore, its effect on signal distortion increases with the spectral width of optical source. (spectral width means band of wavelength over which the optical source emits light)

It is of two types

→(a) Material Dispersion :- Refractive index of a material is different for different wavelength. Any source of light emits a wide range of wavelength. Thus, different wavelength component of optical Pulse have different transist time & therefore the spectral Component of Pulse Combine to produce broadened pulse with lower peak amplitude at Output end. The broadening is expressed as

$$\tau_{max} = N(\lambda)\,\Delta\lambda\,L$$

where $N(\lambda)$ = material dispersion
$\Delta\lambda$ = Spectral Width
L = length of optical fibre

(2) <u>Waveguide Dispersion</u>:-
This kind of dispersion arises due to geometry of waveguide (optical fibre). In a single mode optical fibre, 80-90% of total optical Power travels through the core while 10-20% of the Signals travelling through cladding. But Refractive index of cladding is slightly lesser than refractive of core, so the light signals propagating through cladding travels faster than the light Signals propagating through Core. This dispersion is called waveguide dispersion.

As we know, there are two layers of different Refractive Index in fibre, so effective refractive index is given by.

$$n_{eff} = \frac{a+t}{\left(\frac{a}{n_1}+\frac{t}{n_2}\right)}$$

where
a = radius of core
t = thickness of cladding layer.

Due to minute geometrical changes, the value of a f t are not constant in optical fibre so effective Refractive Index will changes. This results in dispersion of signals. This dispersion even present in Singlemode optical fibre. It will be present even when intermodal f material dispersion are absent because this dispersion arises due to the geometry of fibres only.

So, Total Dispersion delay (Pulse dispersion)

$$\tau_{Total} = \sqrt{\tau_{inter}^2 + \tau_{mat}^2 + \tau_{waveguide}^2}$$

(2) Intermodal Dispersion :-

This dispersion is also known as Modal Dispersi. It arises due to the difference in time taken by various modes to travel along optical fibre. This dispersion is doesnot depends on wavelength of light, but depends on the angle at which ray of light strike core-claidding interface of multimode fibre

Let n_1 = Refractive Index of core
n_2 = Refractive Index of cladding.

Let $AB = x$ = distance travelled by ray of light

In ΔABD

$$\sin i = \frac{AD}{AB} = \frac{z}{x}$$

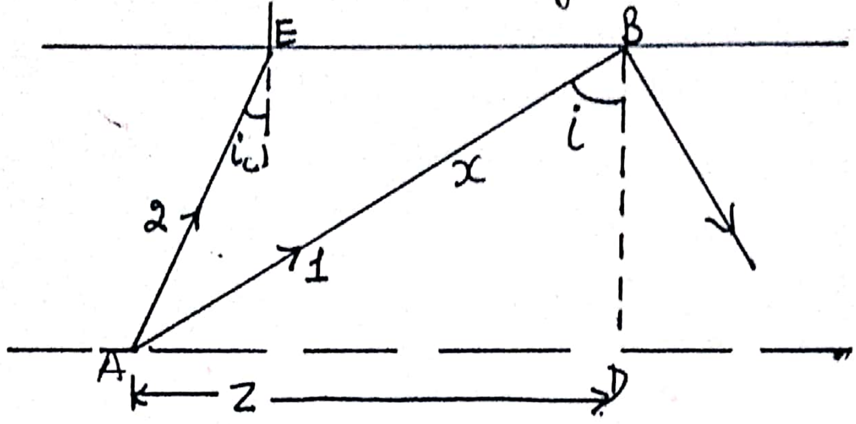
where z = Linear distance travelled by ray of light along the axis of fibre

$$x = \frac{z}{\sin i}$$

then, L = length of fibre.

$$x_{total} = \frac{L}{\sin i}$$

x_{total} is maximum when i is minimum & minimum allowed value of i is critical angle i_c



$$x_{max} = \frac{L}{\sin i_c}$$

$$\boxed{x_{max} = \frac{L n_1}{n_2}} \qquad \left(\because \sin i_c = \frac{n_2}{n_1}\right)$$

The value of x_{total} will be minimum when i is maximum

$$x_{min} = \frac{L}{\sin 90^\circ}$$

$$\boxed{x_{min} = L}$$

→ Thus, maximum difference in actual path length of the rays reaching to other end of fibre is

$$(\Delta x)_{max} = x_{max} - x_{min}$$

$$= L\left[\frac{n_1}{n_2} - 1\right]$$

$$= L\left[\frac{n_1 - n_2}{n_2}\right]$$

$$(\Delta x)_{max} = L\left[\frac{n_1-n_2}{n_2} \times \frac{n_1}{n_1}\right]$$ {Multiply & divide by n_1}

$$(\Delta x)_{max} = L\left[\Delta \times \frac{n_1}{n_2}\right] \quad \text{——(1)}$$ $\left(\because \frac{n_1-n_2}{n_1} = \Delta\right)$

As we know;

$$\Delta = \frac{n_1-n_2}{n_1}$$

$$\Delta = 1 - \frac{n_2}{n_1}$$

$$\frac{n_2}{n_1} = 1-\Delta \Rightarrow \frac{n_1}{n_2} = \frac{1}{1-\Delta}$$

Now put the value of $\frac{n_1}{n_2}$ in Eqⁿ (1)

$$(\Delta x)_{max} = \frac{L\Delta}{1-\Delta} \quad \text{——(2)}$$

we know

$$n_1 = \frac{c}{v}$$ {where v = velocity of mode in Core}

$$v = \frac{c}{n_1} \quad \text{——(3)}$$

⇒ Thus maximum time delay b/w highest & lowest mode is given by

$$\tau_{int} = \frac{(\Delta x)_{max}}{v}$$

$$\boxed{\tau_{int} = \frac{L\Delta n_1}{(1-\Delta)c}}$$ {by using Eqⁿ (2) & (3)}

This time delay is also called dispersion delay. It is order of nanosecond per kilometer. This delay is not present in single mode optical fibre. In case of graded index optical fibre this delay is

$$\tau_{int} = \frac{n_1 L \Delta^2}{8c}$$

The intermodal dispersion is much lower in graded index optical fibre.

Qu What are the different losses that takes place in optical fibre? How do you express losses?

Losses in optical fibre

or

Attenuation

Attenuation of an optical fibre means loss of optical power in the fibre itself. It is defined as ratio of optical power output obtained from a fibre of given length to the optical power input fed into the fibre.

Losses are expressed in decible/km

Different types of losses are

1) Material loss
2) Rayleigh scattering loss
3) Absorption loss
4) Leaky Modes
5) Mode coupling loss
6) Geometric or Bending loss
7) Radiation or Induced loss
8) Temperature dependent loss

(1) Material loss :- In fabrication of various types of optical fibre, we use GeO_2, P_2O_5 etc. as a dopant in order to modify its refractive index. These dopant absorb the wavelength range.

(800nm to 1300 nm). Since optical Carrier wavelength also falls in this range, thus these materials causes loss of optical power by absorbing it.

(2) <u>Rayleigh Scattering loss</u>:- During manufacturing of fibre large number of inhomogeneities appear in the material, due to fluctuation in density, & presence of impurity atom. These inhomogeneit act as scattering centres. This loss of signal is called Rayleigh Scattering loss. ($I \propto \frac{1}{\lambda^4}$)

(3) <u>Absorption loss</u>:- This kind of loss is caused by varying nature of core. when light falls on transparent medium, a part of it is reflected & some part is absorbed & remaining part is transmitted. The absorption of light by core medium can takes by via three mechanism

→ ultraviolet absorption
→ Infrared absorption
→ Ion resonance.

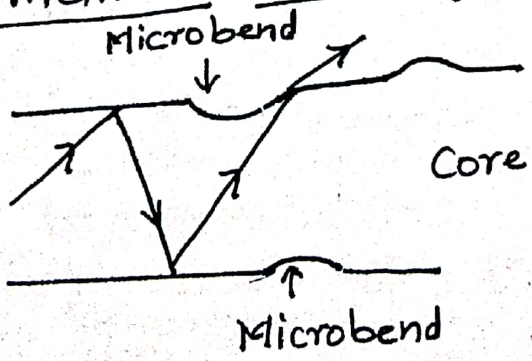
During manufacturing process, minute quantities of water molecules are trapped in glass fibre. These water molecules contribute OH^- ions to the material. A concentration of OH^- ions of 1 part in billion can causes 1 dB/km loss at 950 nm.

(4) <u>Leaky Modes</u>:- we know that propagation of light through fibre can take place via meridional rays or skew rays. The skew rays

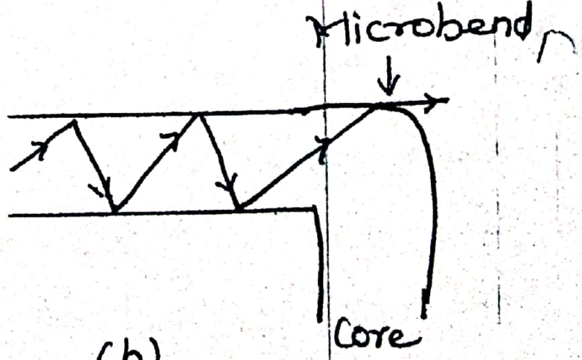
suffer only partial reflections while meridional rays are completely guided. Thus the modes allowing propagation of skew rays are called leaky modes. optical power is lost into the cladding due to these modes.

(5) Mode Coupling loss :- it is not possible to manufacture a single fibre of infinite length. thus we often have to connect two or more fibre to increase length. further these tapped at a large number of points. The device used to connect two or more fibres are known as fibre splicer or fibre connectors depending upon nature of joint i.e. (If it is permanent joint → → fibre splicer, If it is demountable joint → → fibre connector). These devices may not be able to transmit all the power to the next fibre. due to improper matching of cores. Such kind of optical power loss is called mode coupling loss

(6) Geometric or Bending loss :-



(a)



(b)

As shown in fig, Here core is shown to be of uniform diameter, so that a ray of light will suffer total internal reflection repeadly

However, it is not possible to make core of uniform diameter. The diameter of core may be varying at certain diameter. These locations are called microbends. When ray of light strikes at microbend then by chance the angle of incidence may become less than critical angle. Hence ray ... leak into cladding. This kind of loss is called Microbending loss.

A microbend is the bend in entire cable, which causes certain modes, not to be reflected & therefore causes the loss of signal into cladding.

(7) <u>Radiation induced loss</u>:- When material of glass interacts with electrons, neutrons, gamma rays & x rays, the structure of glass molecules is altered & fibre darkens. This result in additional loss of optical power. This loss is called radiation induced loss.

(8) <u>Temperature dependent loss</u>:- If the temp. of fibre is less than $-10°c$ then differential thermal expansion b/w polymer coating & glass causes stress, which creates a microbends & result in loss of power.

<u>Total Attenuation</u>:-

Let $P_0 \rightarrow$ optical Power input fed into input of the fibre.

$P \rightarrow$ optical Power at distance x from the input of fibre.

Let $-\frac{dP}{dx}$ = rate of decrease of Power w.r.t distance.

As $-\frac{dP}{dx}$ at any point is directly propotional to the optical power at that point

So,

$$-\frac{dP}{dx} \propto P$$

$$-\frac{dP}{dx} = \alpha_p P$$

where α_p = Const. of Proportionality / Attenuation Const.

$$\frac{dP}{P} = -\alpha_p \, dx.$$

$$\int_{P_0}^{P} \frac{dP}{P} = \int_{0}^{x} -\alpha_p \, dx$$

$$\ln\left(\frac{P}{P_0}\right) = -\alpha_p x.$$

$$\frac{P}{P_0} = e^{-\alpha_p x}$$

$$\boxed{P = P_0 e^{-\alpha_p x}.}$$

$$\boxed{\alpha_p = \frac{10}{x} \log_{10}\left(\frac{P_0}{P}\right)}$$

Differerent Methods of Joining or Connecting Optical fibre

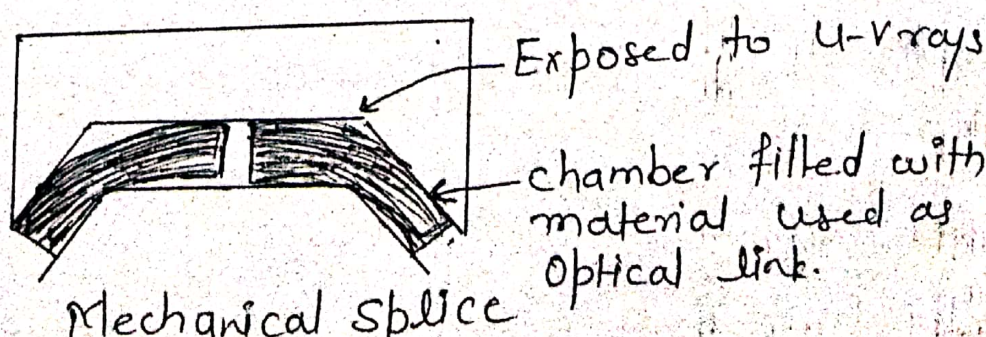
→ fibre Splicer
→ fibre Connectors
→ fibre Couplers

(1) **fibre splicing** :- Permanent bond bt/w two or more optical fibres with the help of optical cement (Same as core material)
Two types of splicing techniques are explained below

(i) **Fusion splicing** ;- In this type of splicing, fibre ends are brought closer & fused together with the help of electric arc.

Different ways of aligning the fibre :-
→ Naked Eyes
→ Camera.
→ Microscope (Best alignment method)
→ PAS :- Profile alignment System consist (camera + Microscope) designed in Such a way that it will program only when alignment is straight

(ii) **Mechanical splicing** :- (involved machinery)



Mechanical splice

It consist of device usually made up of glass which automatically bring the two fibres into alignment & splice is filled with material used as optical link & whole assembly is exposed to u.v light which cures the cement.

⇒ **Fibre Connectors:-**
Demountable joints b/w two or more fibres is called Connectors

Principle requirements of good Conductor design

→ Easy of assembly
→ Easy Connection
→ low Coupling loss
→ low enviornment sensitivity.
→ low cost & more reliable.

Types of Connectors (depending upon Configuration)
(i). Bayonet
(ii) Push Pull configurations
(The basic Coupling mechanism used in these connectors are expanded-beam or butt joint classes

⇒ **Fibre Couplers:-** These are special devices with one or many input fibres & one or many output fibres

Types of optical fibre
↓ T Coupler
↓ Y Coupler

→ If power divided in an uneven or unequal manner is Y Coupler
→ If power divided in an even or equal manner is T coupler.

Advantages of optical fibre over general communication cable:-

(1) Extremly large band width :- Information travels much faster as compared to general comm cable i.e

Copper cable :- 10^8 Hz – 10^{10} Hz.

OFC light signals:- 10^{14} Hz – 10^{15} Hz

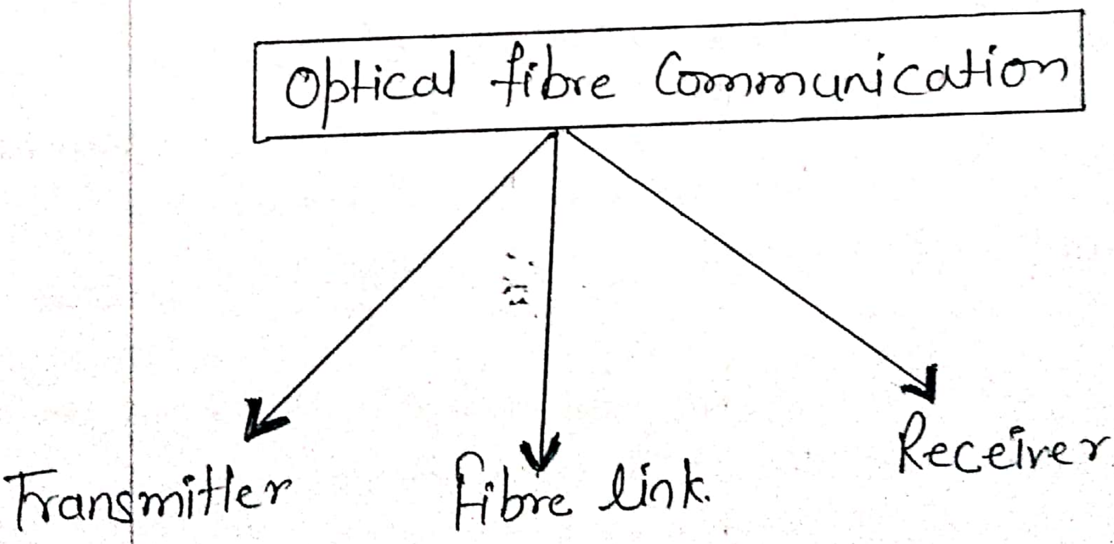
(2) light in weight:-

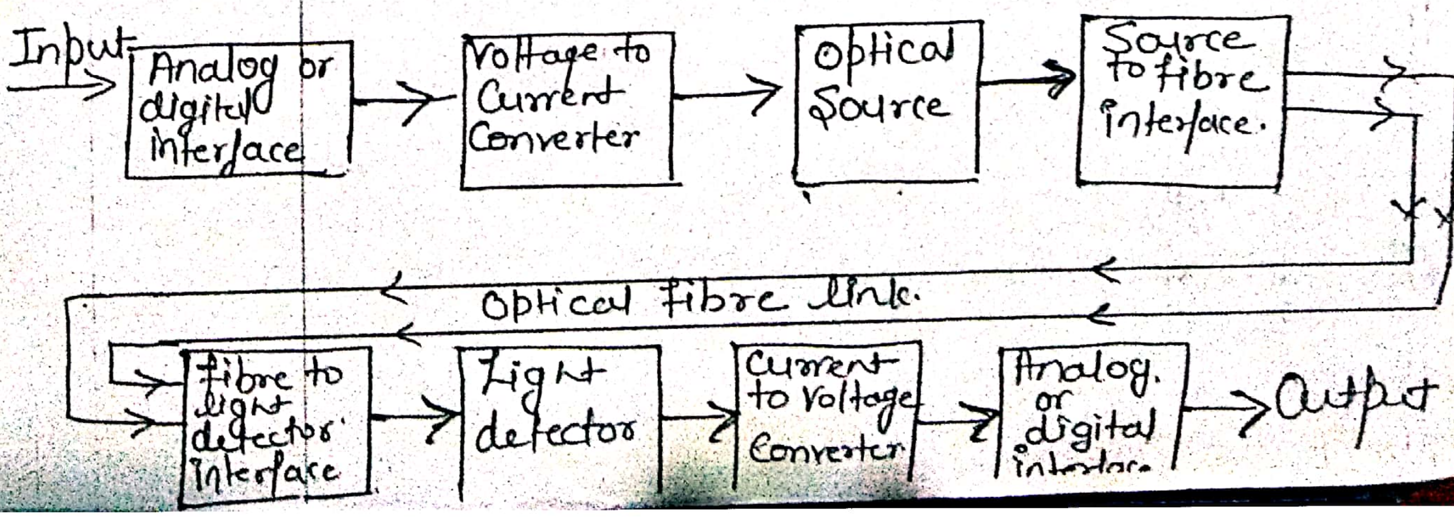
(3) No cross connections – (Glass insulating properties)

(4) Life time :- 10 – 20 Years

(5) Signals delivered at low cost.

→ OPTICAL FIBRE COMMUNICATION





(1) Transmitter :- It has different parts

→ Analog or digital interface :- It provides an electric signals in analog or digital form

→ Voltage to Current Converter :- It serves as a interface between input circuit & optical source & convert electrical signals to optical signals

→ Optical Source :- It does modulation of optical signals

→ Source to fibre interface :- It couples light signals emitted by optical source to optical fibre cable

(2) Optical fibre link :- It act as transmission medium by which modulated signals can be carried from one place to another.

(3) Receiver :- It has following parts :-

→ Fibre to light interface :- It couples light signals from fibre cable into light detector.

→ Light detector :- It convert light signals into current

→ Current to Voltage Converter :- It transforms current into output signal voltage.

→ Analog or digital interface :- It couples output signal voltage to the output.

Applications of optical fibre :-

① **Medical Applications :-** 1) A bundle of fibres are used to illuminate that portion of human body which is inaccessible & second bundle of fibres are used to collect reflected light. Such arrangement is called fibrescope & used in endoscopic applications.

(2). optical fibre in surgery avoids damage of tissues due to heat.

(3). To correct defect of vision, optical fibre with a guided laser beam is used

② **Defence applications**

(1) Fibre guided weapons system are used in military

(2) They are used in remote monitoring system

③ **Communication Applications !-**

(1) In telephone communication, an optical fibre of 0.5 inch diameter can carry, 80,000 conversation at a time.

(2) They are used in computers for transmition of digital informations from one source to another

④ **Fibre Thermometer :-** As temperature rises, difference in refractive index of core & cladding reduces so fibre thermometers are used having range 80 - 700°c.

(5). Smoke & pollution detector :- Beam of light radiations from one end of fibre can be collected by other fibre. If the foreign (dust particle) particles are present, they scatter light & variation in intensity of light from fibre confirms presence of smoke.

(6) Consumer Product Applications :-

→ used in Home monitoring system (CCTV)

→ Many electronic applications like power windows, mirror control etc. uses optical fibre