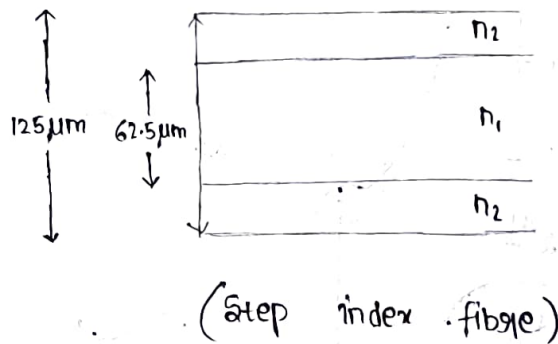
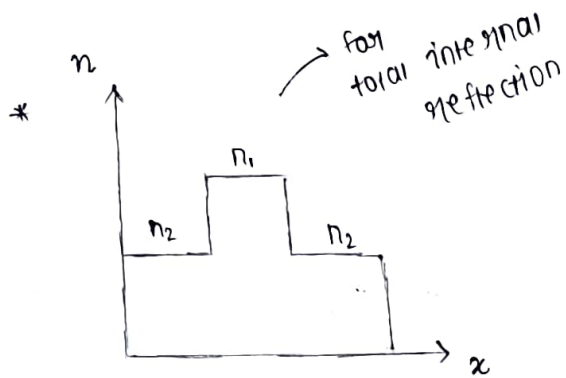
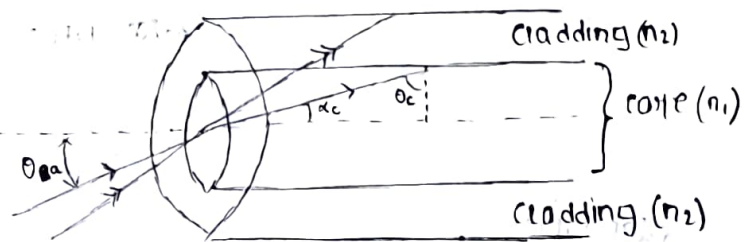


# # CONDITION FOR LIGHT PROPAGATION IN OPTICAL FIBRE :



(step index fibre)

\* Applying Snell's law at the core-cladding boundary we get :

$$n_1 \sin \theta_c = n_2 \sin 90^\circ$$

$$\Rightarrow \sin \theta_c = \frac{n_2}{n_1}$$

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

\*  $\alpha_c$  is the "critical propagation angle"

$$\theta_c = 90^\circ - \alpha_c$$

$$\sin \theta_c = \cos \alpha_c$$

$$\sin \alpha_c = \sqrt{1 - \cos^2 \alpha_c} = \sqrt{1 - \left( \frac{n_2}{n_1} \right)^2} = \sqrt{\frac{n_1^2 - n_2^2}{n_1^2}}$$

\* Applying Snell's law at the gap fibre interface

$$n_a \sin \theta_a = n_1 \sin \alpha_c, \quad \theta_a \rightarrow \text{acceptance angle.}$$

$$\Rightarrow \sin \theta_a = \frac{n_1}{n_a} \left( \frac{\sqrt{n_1^2 - n_2^2}}{n_1} \right) = \frac{\sqrt{n_1^2 - n_2^2}}{n_a}$$

if outside medium is air :  $n_a \approx 1$

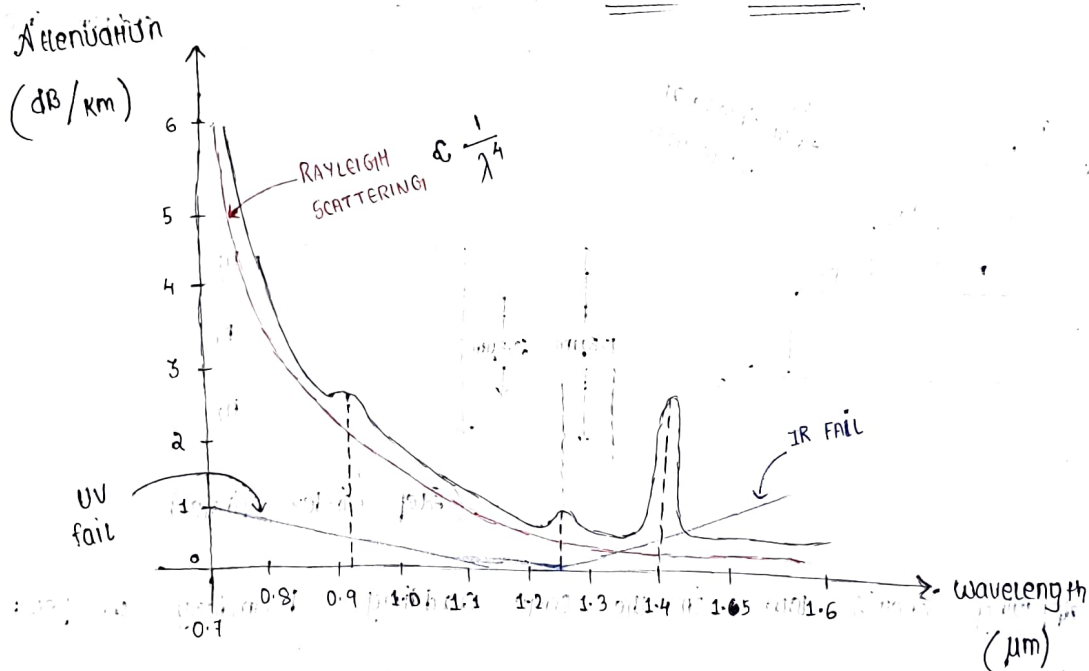
$$\text{then } \sin \theta_a = \sqrt{n_1^2 - n_2^2}$$

numeric aperture

$$NA = \sqrt{n_1^2 - n_2^2}$$

$$NA = n_1 \sqrt{2\Delta} \quad , \quad \Delta = \frac{n_1 - n_2}{n}$$

### Losses in fiber optics

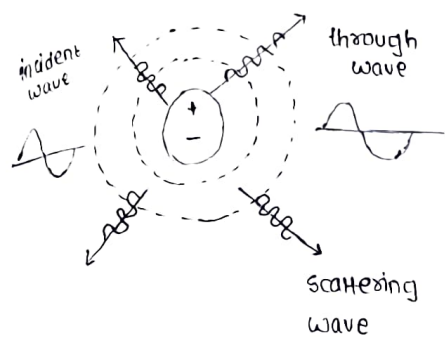


(Silica gel loss spectrum)

→ Three types of losses :

- \* **Absorption loss :** It is the process of conversion of EM waves energy into other forms of energy. Intrinsic silica glass absorption occurs in both UV & IR while UV losses increase at lower wavelength, IR losses increase at higher wavelength.

\* Rayleigh scattering loss : It is a wavelength dependent



process, that depends on material inhomogeneities smaller than wavelength.

It is inversely proportional to  $\lambda^4$ .

This strong dependence of loss due to

Rayleigh scattering on wavelength,

restricts the operation of silica optic fibre

at lower wavelengths. The loss peaks occur

at points of wavelength :

Peaks.

① - 0.93  $\mu\text{m}$

② - 1.25  $\mu\text{m}$

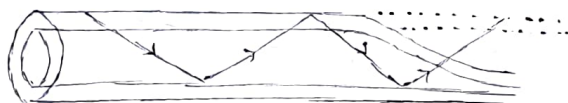
③ - 1.40  $\mu\text{m}$

} for silica gel form  
left graph.

\* Bending loss :

Bending the fibre also causes attenuation. This is not strongly dependent on wavelength. It is classified as micro & macro bending.

• Microbends are small microscopic bends of fibre axis, that occur mainly, when a fibre is scabbed.



micro

• Macrobends are bends that have large <sup>radius of curvature</sup> ~~bends~~ relative to the <sub>fibre</sub> diameter.