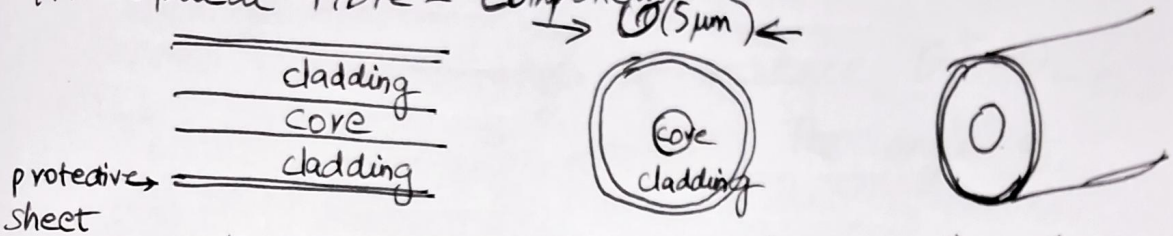
Optical fibre (Light pipe)

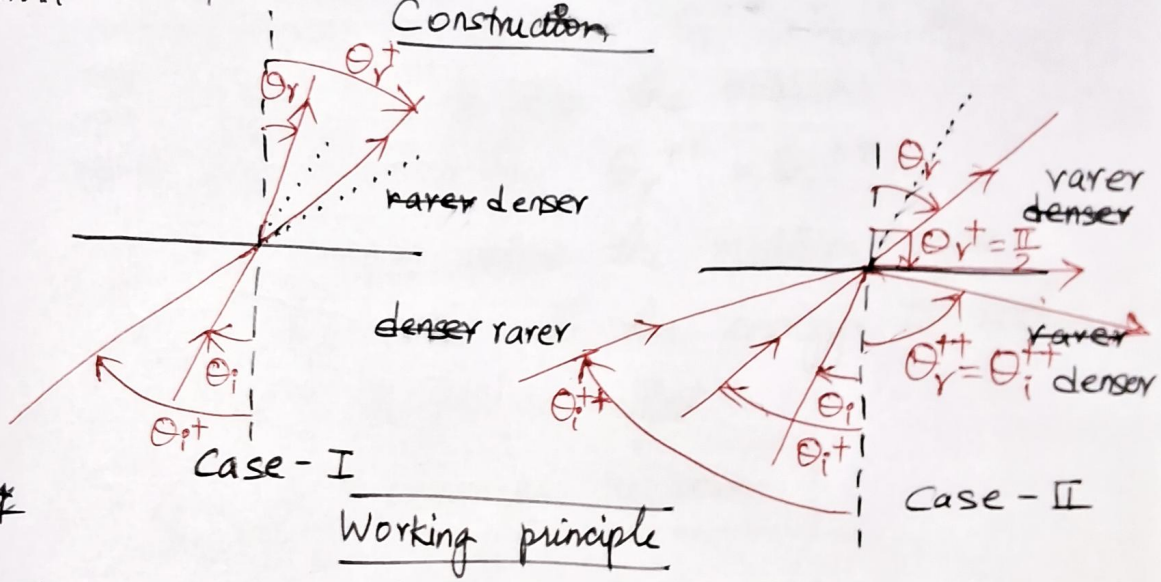
- Is an optoelectronic device that is the backbone of modern communication systems.
- Useful for long-distance communication
- Harnesses the speed of light and the properties of propagation of light across media with different refractive indices

Optical fibre - Components



Optical fibre - requirements

Construction



Working principle

- The speed of light varies in different medium
- It is highest in vacuum and is given by $v = c$
- In other medium, it is quantified by the refractive index n, so that velocity of light in the medium is $v = \frac{c}{n}$.

- Typical media that light propagates in have refractive indices as

medium	n
air	1
water	1.33
glass (silica)	1.5

- At the interface of media, speed of light changes. To account for this change, two cases are possible

  Case I light propagates from rarer to denser

  Case II light propagates from denser to rarer

~~Rarer to denser~~ ~~Denser to rarer~~ Rarer to denser

Consider light is incident at an angle of incidence θ_i with respect to normal

Since the light is faster in rarer medium, ~~it bends away from normal~~ and slower in denser medium, it bends towards the normal. Therefore, it refracts.

And angle of refraction is less than angle of incidence

$$\theta_r < \theta_i$$

Similarly, for larger angle of incidence θ_i^+, light refracts with angle of refraction $\theta_r^+ < \theta_i^+$.

~~Rarer to denser~~ Denser to rarer

Since the light is ~~fast~~ slower in denser medium and faster in rarer medium, it bends away from the normal.

Case (i)

For angle of incidence θ_i, consider the light refracts with angle of refraction θ_r.

Here $\theta_r > \theta_i$

Case (ii)

At a critical angle of incidence $\theta_i^{+} = \theta_c$, the light grazes the interface. The angle of refraction $\theta_r^{+} = \frac{\pi}{2}$

Case(iii)

For angle of incidence $\theta_i^{++} > \theta_c$, the light reflects back into the medium.

The angle of reflection $\theta_r^{++} = \theta_i^{++}$

Since the light enters the medium again with reflection and all the energy is within the medium, ~~It~~ it is called

total internal reflection

∴ (TIR) is required for light containment within the optical fibre.

This is possible if refractive index of core is greater than refractive index of cladding