**Classification Based on Material:** On the basis of materials used for core and cladding, optical fibres are classified into three categories**.**

**(a) Glass/glass fibres (glass core with glass cladding)**

The basic material for fabrication of optical fibres is silica ($SiO_2$). Material having slightly different refractive index is obtained by doping the basic silica material with small quantities of various oxides. For example, if the basic silica material is doped with Germania oxide ($GeO_2$) or phosphorous pentoxide ($P_2O_5$) , the refractive index of the material increase. Such material are used as core material and pure silica as used as cladding material. The glass optical fibres exhibit very low losses and are used in long distance communications.

**(b) Plastic/plastic fibres (plastic core with plastic cladding)**

Poly(methyl methacrylate) (PMMA) and polystyrene are used for core. A fluorocarbon polymer or silicon resin is used as a cladding material. A high refractive index difference is achieved between the core and the cladding materials. Therefore plastic fibres have large NA of the order of 0.6 and large acceptance angle up $70^0$. The main advantages of the plastic fibre are low cost and higher mechanical flexibility. However, they're temperature sensitive and exhibit very high loss. Therefore, they are used in low cost application and at temperature bellow $80^0$C.

(c) **PCS (Polymer clad silica)**

The plastic clad silica fibres are composed of silica cores and surrounded by a low refractive index transparent polymer as cladding. The core is made from high purity quartz. The cladding is made of silicon resin having a refractive index of 1.338. The plastic cladding is less expensive but has high losses. Therefore, they are mainly used in short distance communication.

**Classification of Fibre based on propagation mode:**

**Single mode Fibre:** In single mode fibre light can travel in single path that is along the axis of the fibre. In case of single mode fibre, we can have waves with different frequencies but of the same mode.

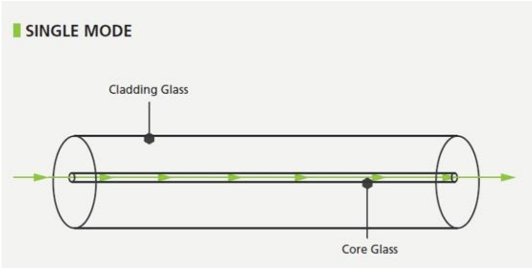


**Fig. 5:** Light propagation in a single mode fibre

**Multimode Fibre:** In this case light follows a number of paths to propagate through the fibre. The core size of multimode fibre is much larger than that in single mode fibre as shown in Fig.6

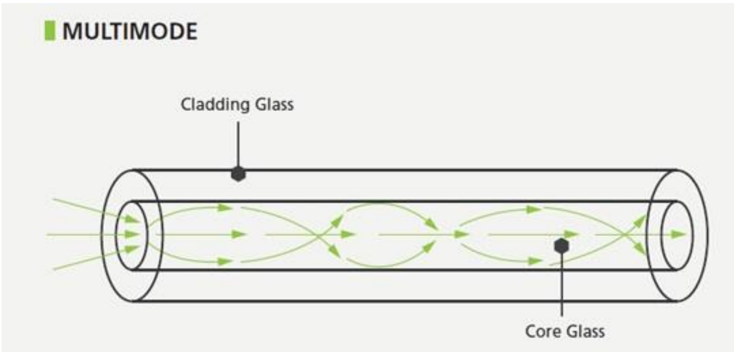


**Fig. 6:** Light propagation through multimode fibre.

**Classification based on refractive index profile:**

Refractive index profile of an optical fibre is basically a plot of refractive index in one axis and the distance from the core axis drawn on the other axis. Optical fibre is divided into two categories based on the refractive index profile.

(a) **Step index fibre:** In this fibre the refractive index of the core is constant along the radial direction and abruptly falls to a lower value at the core-cladding boundary which is shown in Fig. 6(a)

(b) **Graded index fibre (GRIN):** In GRIN Fibres, the refractive index of the core is not constant but varies smoothly over the diameter of the core. It has a maximum value at the center and decreases gradually towards the core-cladding boundary. The refractive index of cladding is constant as shown in Fig. 6(b)

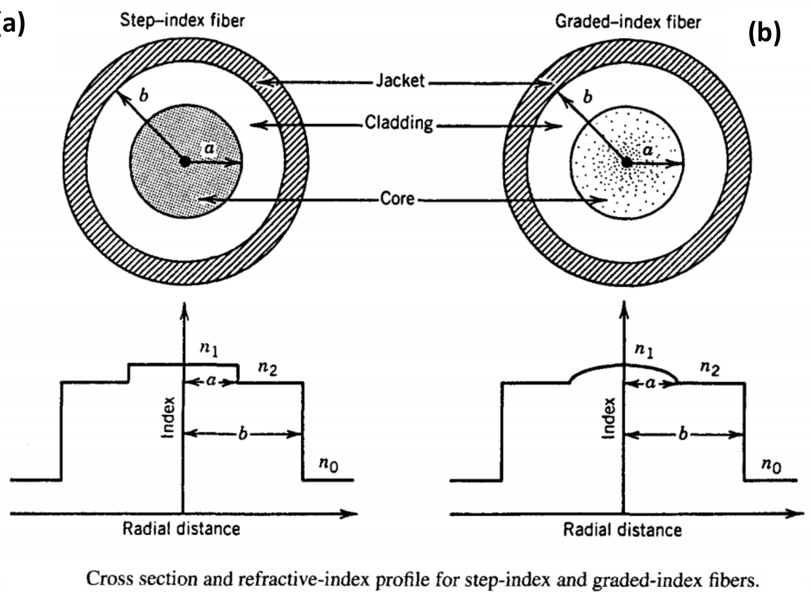


**Fig. 6:** Refractive index profile of (a) step index fibre (b) graded index fibre (GRIN)

**Propagation of light in GRIN fibre:** The variation of refractive index of the core with radius is given by

$$n\,(r) = \left\{ n_1\sqrt{1-\left[2\Delta\left(\frac{r}{a}\right)^{\alpha}\right]} \right\}, \qquad r<a,\ \text{inside core}$$
$$= \qquad n_2 \qquad\qquad r>a \quad \text{in cladding}$$

Where $n_1$ is the maximum refractive index at the core axis, a the core radius and α the grading profile index number which varies from 1 to ∞

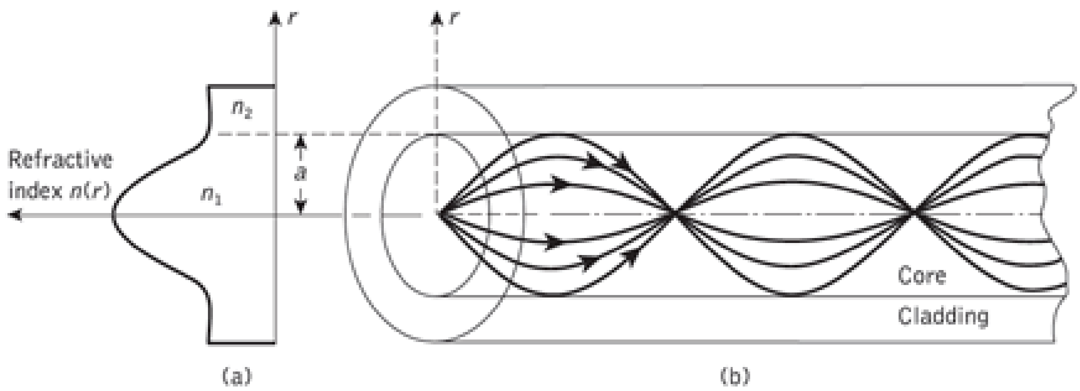


**FIG.7: (a)** Refractive index profile and **(b)** light propagation in GRIN fibre

When light ray travels from a region of larger refractive index to a region of lower refractive index region, it is bent away from the normal till the condition of total internal reflection.

Then the ray travels back towards the core axis, again being continuously refracted. The total internal reflection of the ray may happen even before reaching the core-cladding boundary. Accordingly continuous refraction is followed by total internal reflection and again continuous refraction towards the axis. In GRIN fibre rays making larger angles with the axis traverse longer path. However they travel in a index at a higher speed of propagation. Consequently all rays travelling through the fibre, irrespective of their optical path length will reach the output end of the fibre at the same time. The propagation mode in GRIN fibe is shown in Fig. 7 (b).

**Optical Fibre Communication System:** The typical block diagram of fibre optic communication system is shown in Fig. 8. The transmitter converts electrical signal into light signals. The transmitter consists of a light source supported by necessary drive circuit. The light source is either a light emitting diode or semiconductor laser. The light signal along with message is transmitted through an optical fibre. At the end of the fibre, the receiver receives the optical signals and converts into electrical signals using a photodetector (photodiode). The converted electrical signals are then amplified and decode to obtain the message. The output is fed to a suitable transducer to convert the messages into an audio or video form.

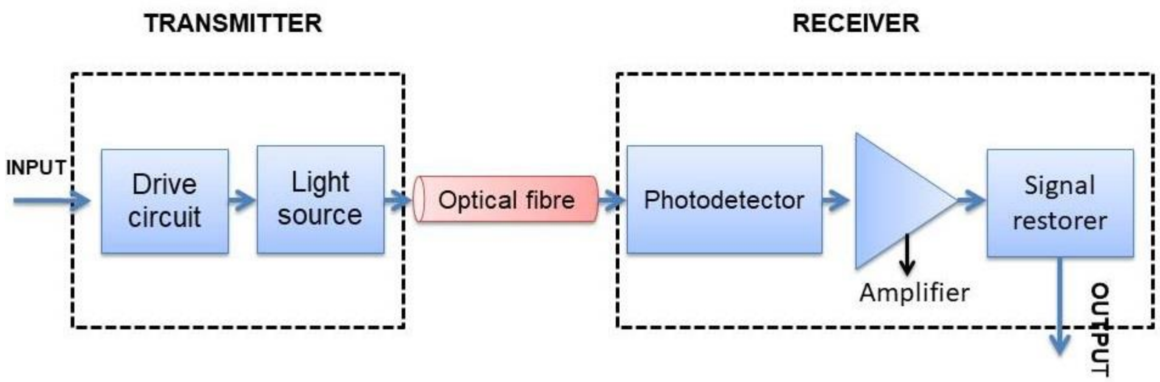


**Fig. 8:** Block diagram of optical fibre communication system.