CLASSIFICATION OF OPTICAL FIBER

➔ Optical fibers are classified into various types based on different parameters as follows.

(i) Classification based on materials:

➔ Optical fibers are classified into 3 categories based on the materials used for the core and cladding.They are

1.Glass|Glass fibers

2.Plastic|plastic fibers

3.PCS (polymer clad silica) fiber

1.Glass|Glass fibers: These fibers have a glass core with glass cladding.

2.Plastic|plastic fibers: These fibers have a plastic core with plastic cladding.

3.PCS (polymer clad silica) fiber: This type of fiber has a silica core with polymer cladding.

(ii) Classification based on R.I. Profile:

➔ R.I. profile: Refractive Index profile of an optical fiber is a plot of Refractive Index(R.I.) drawn on one of the axes and the distance from the core axis drawn on the other axis.

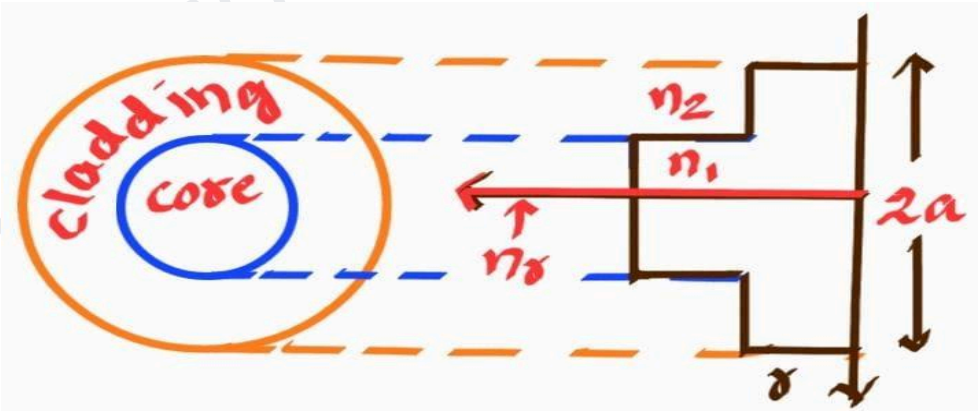
➔ Optical fibers are classified into 2-categories based on R.I. profile. They are

1.Step Index(STIN) fiber

2.Graded Index (GRIN) fiber.

1.Step Index fiber(STIN):-

➔ Step index means the RI of the core is constant along the radial direction and abruptly falls to a lower value at the cladding and core boundary.

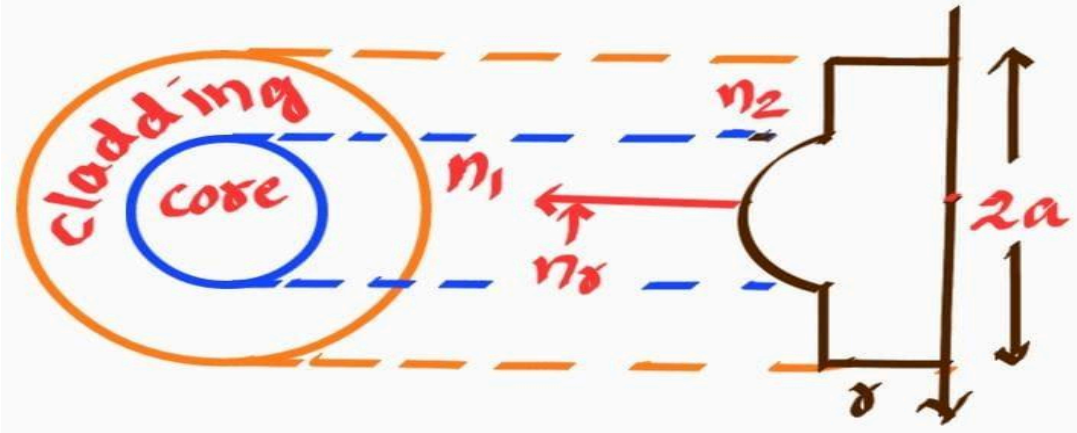


2.Graded Index (GRIN) fiber: -

➔ GRIN means the R.I. of the core is not constant but varies smoothly over the diameter of the core.

➔ It has the maximum value at the Centre and decreases gradually towards the outer edge of the core.

➔ At the core-cladding interface, the R.I. of the core matches with the R.I. of the cladding & the R.I of cladding is constant.



(iii) Classification of Fibers based on modes

➔ On the basis of the modes of light propagation, optical fibers are classified into two categories. They are:Single mode fibers and Multimode fibers.

➔ A single mode fiber has a smaller core diameter and can support only one mode propagation.

➔ A multimode fiber has a larger core diameter and can support a number of modes.

➔ Thus, on the whole, the optical fibers are classified into 3-Types They are

1.Single mode step index fiber (SMSF)

2.Multimode step index fiber (MMSF)

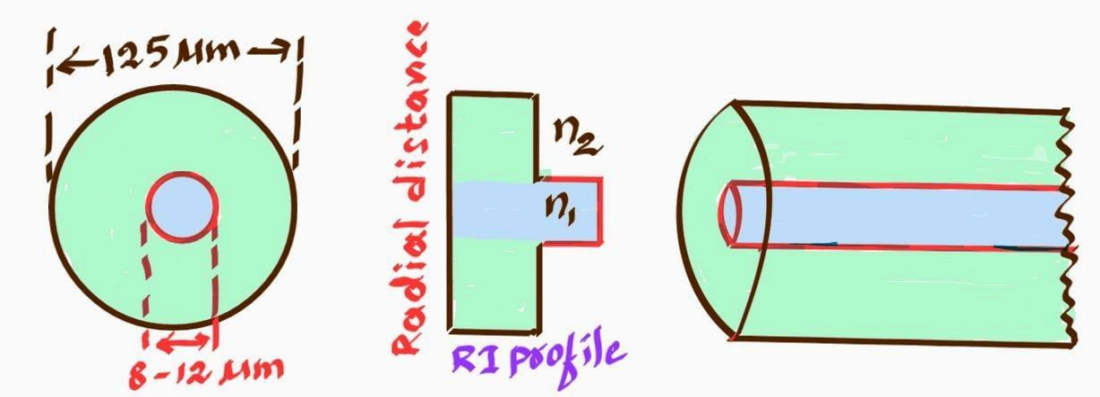
3.Graded Index (multimode) Fiber (GRINF)

1.Single mode step index fiber (SMSF):

➔ It has a smaller core diameter and can support only one mode of propagation & high bandwidth structure.

➔ **Structure:** A single mode step index fiber has a very smaller core of diameter 8 to 12 μm.

➔ Core is generally made up of Ge doped Si and is enclosed by a thick cladding of lower Refractive index.



- ➔ The cladding is composed of silica which is lightly doped with phosphorus oxide.
- ➔ The external diameter of the cladding is 125 μm. (& inner diameter of cladding is 65 μm).
- ➔ The fiber is surrounded by a non-transparent shielding sheath.
- ➔ The Refractive Index(R.I.) of the fiber changes abruptly at the core-cladding boundary.
- ➔ The variation of R.I. of a SMSF as a function of radial distance can be **mathematically** represented as:

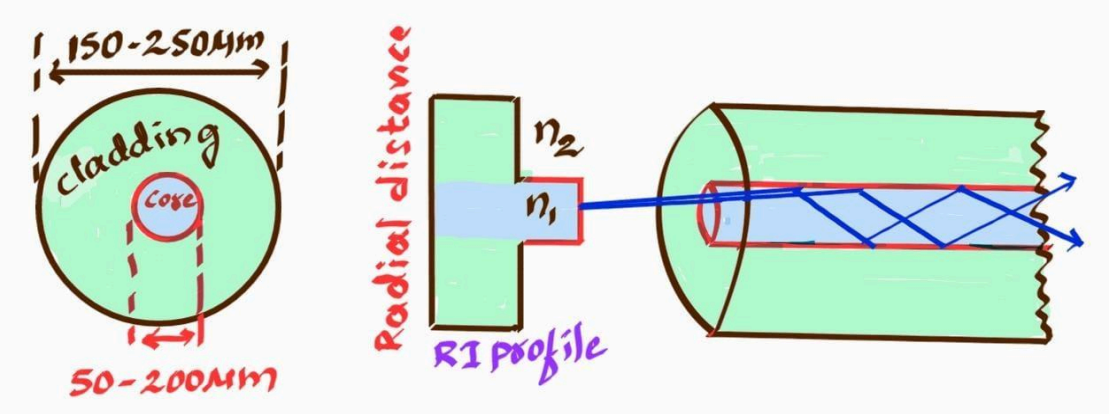
  $n(r) = n_1$ [r < a inside core]

  $n(r) = n_2$ [r > a in cladding]

- ➔ **Propagation of Light:**
- ➔ Light travels in an SMSF is a single path along the axis and it is a zero-order mode supported by a SMSF because of the smaller Refractive Index(R.I) & Numerical Aperture(NA).
- ➔ It can be achieved by reducing the fiber radius and \Delta (Relative R.I. change).
- ➔ The low NA indicates a low acceptance angle and the difficulty in light coupling into the fiber.
- ➔ It is used as underwater cables.

2.Multimode Step Index fiber:

- ➔ MMSF has a larger core diameter and supports a number of modes.
- ➔ It is easy to manufacture and is used in data links.
- ➔ **Structure:**
- ➔ A multimode step index fiber is very much smaller to the single mode step index fiber except that its core is of larger diameter.
- ➔ The core diameter is of the order of 50 to 200 μm, which is very large compared to the wavelength of light.
- ➔ The external diameter of the cladding is about 150 to 250 μm.



➔ **Propagation of Light:**

➔ MMSF allows a finite number of guided modes.

➔ The direction of polarization & alignment of Electric, magnetic fields will be different in rays of different modes or zigzag paths of propagation.

➔ The length of the path along the axis of the fiber is shorter while the other zigzag paths are longer.

➔ Because of this difference, the lower order modes reach the end of the fiber earlier while the other modes reach after some time (delay).

➔ It is used in data links.

Graded Index (GRIN) Fibers:

➔ GRINF is multimode fiber with a core consisting of concentric layers of different refractive indices.

➔ The R.I of core varies with distance from the axis but R.I of cladding is uniform and < core.

➔ LED or LASER can be used as the source of light with it.

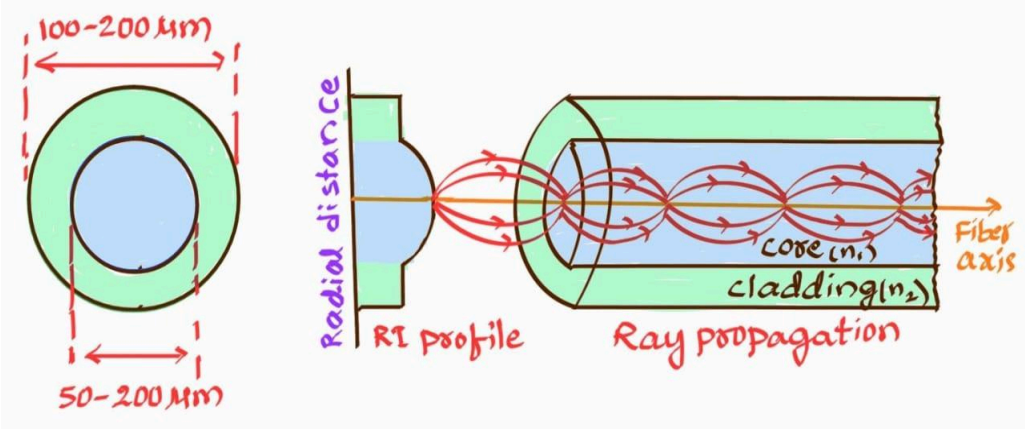
➔ GRINF can be used in Telephone links.

➔ **Structure:**

➔ GRINF having parabolic R.I profile and is similar geometry to that of MMSF.

➔ The diameter of the core is about 50 to 200 μm, which is very large compared to the wavelength of light.

➔ The diameter of the cladding is about 100 to 250 μm.



➔ **Propagation of Light:**

➔ Due to the parabolic R.I profile, there is a self-focusing effect. So the light rays propagating at different speeds in different paths through the fiber are continuously refocused and almost all the rays reach the exit end of the fiber simultaneously.

➔ **Explanation:**

➔ Let us consider a single pulse (ray) travelling through graded index fiber in two different paths (trajectories) respectively by 1 & 2.

➔ The ray 1, travelling along the axis of the fiber in a shorter path with a higher R.I.

➔ The other ray 2, travelling away from the axis undergoes refraction and moves in a longer path with lower R.I.

➔ It is clear that light waves with a large angle of incidence travel longer paths than those with smaller angles.

➔ But the decrease of R.I allows higher velocity of propagation. Thus rays/waves/pulses reach a given point along the fiber at the same time.