

## Types of Optical fibres:

The optical fibres are classified under 3 categories. They are

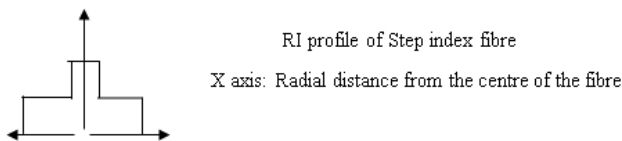
- a) Step index Single mode fibre (SMF)
- b) Step index multimode fibre (MMF)
- c) Graded index Multi Mode Fibre (GRIN)

This classification is done depending on the refractive index profile and the number of modes that the fibre can guide.

### Refractive Index Profile (RI):

Generally in any type of optical fibre, the refractive index of cladding material is always constant and it has uniform value throughout the fibre. But in case of core material, the refractive index may either remain constant or subjected to variation in a particular way.

This variation of RI of core and cladding materials with respect to the radial distance from the axis of the fibre is called refractive index profile. This can be represented as follows,



### Step index Single mode fibre (SMF):

A single mode fibre has a core material of uniform refractive index (RI) value. Similarly cladding also has a material of uniform RI but of lesser value. This results in a sudden increase in the value of RI from cladding to core. Thus its RI profile takes the shape of a step. The diameter value of the core is about 8 to 10  $\mu\text{m}$  and external diameter of cladding is 60 to 70  $\mu\text{m}$ . Because of its narrow core, it can guide just a single mode as shown in Figure. Hence it is called single mode fibre. Single mode fibres are most extensively used ones and they constitute 80% of all the fibres that are manufactured in the world today. They need lasers as the source of light. Though less expensive, it is very difficult to splice them (joining of optical fibres). Since single mode is propagating through the fibre, intermodal dispersion is zero in this fibre. They find particular application in submarine cable system.

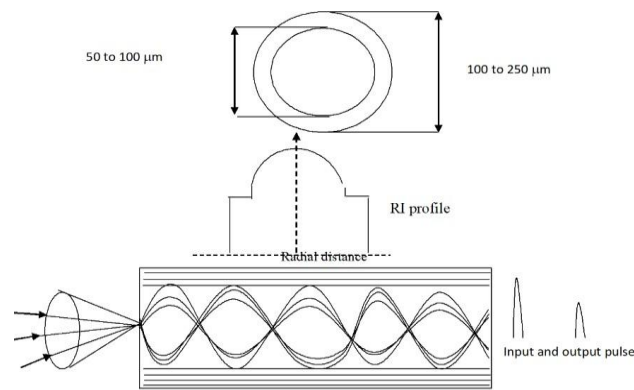


Fig. Graded index multimode fibre

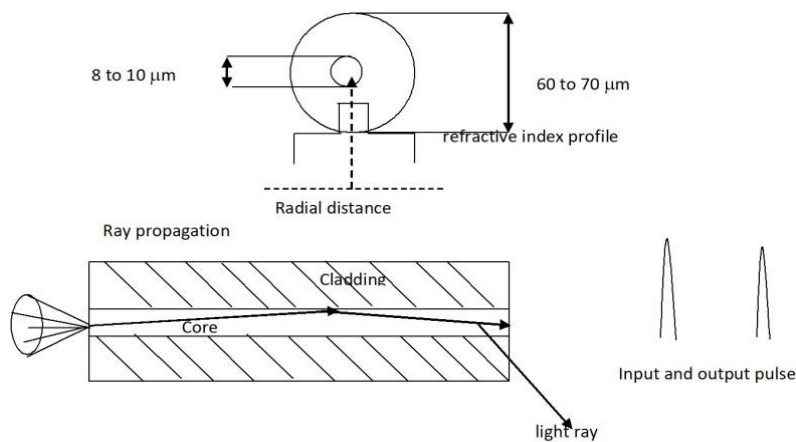


Fig: Step Index Single Mode Fibre

### Step index multimode fibre (MMF):

The geometry of a step-index multimode fibre is as shown in below figure. It's construction is similar to that of a single mode fibre but for the difference that, its core has a much larger diameter by the virtue of which it will be able to support propagation of a large number of modes

as shown in the figure. Its refractive index profile is also similar to that of a single mode fibre but with larger plane regions for the core.

The step-index multimode fibre can accept either diode laser or LED (light emitting diode) as source of light. It is the least expensive of all. Since multi modes are propagating through this fibre with different paths, intermodal dispersion is maximum in this fibre. Its typical application is in data links which has lower bandwidth requirements.

**Differences between single and multimode fibres:**

<b>Single mode fibre</b>	<b>Multimode fibre</b>
<ul style="list-style-type: none"> <li>• Only one mode can be propagated</li> <li>• Smaller core diameter</li> <li>• Low dispersion of signal</li> <li>• Can carry information to longer distances</li> <li>• Launching of light and connecting two fibres are difficult</li> </ul>	<ul style="list-style-type: none"> <li>• Allows large number of modes for light to pass through it</li> <li>• Larger core diameter</li> <li>• More dispersion of signal</li> <li>• Information can be carried to shorter distances only</li> <li>• Launching of light and connecting of fibres is easy</li> </ul>

**Differences between step and graded index fibres:**

<b>Step index fibre</b>	<b>Graded index fibre</b>
<ul style="list-style-type: none"> <li>• Refractive index of core is uniform</li> <li>• Propagation of light is in the form of meridional rays</li> <li>• Step index fibres has lower bandwidth</li> <li>• Distortion is more (in multimode)</li> <li>• No. of modes for propagation <math>N_{\text{step}} = V^2/2</math></li> </ul>	<ul style="list-style-type: none"> <li>• Refractive index of core is not uniform</li> <li>• Propagation of light is in the form of skew rays</li> <li>• Graded index fibres has higher bandwidth</li> <li>• Distortion is less</li> <li>• No. of modes for propagation <math>N_{\text{grad}} = V^2/4</math></li> </ul>