

Unit-1

Lecture -5

Optical fiber Modes, Step Index fiber,
Graded Index Fiber, Configuration

Optical Fiber modes and configurations

- a. Fiber types
- b. Rays and modes
- c. Step-index fiber structure
- d. Ray optic representation

Fiber Types

- An optical fiber is a dielectric wave guide.
- It confines electromagnetic energy in the form of light within the surface of the waveguide.
- It guides the light in a direction parallel to its axis.
- The propagation of light along a waveguide can be described in terms of guided electromagnetic waves.
- These waves are known as “*modes*” of the waveguide.

- Each guided mode is pattern of electric and magnetic field distributions.
- This pattern is repeated along the fiber at equal intervals.
- Only certain no. of modes are capable of propagating along the waveguide.
- These modes are electromagnetic waves and satisfies homogenous wave equation in the fiber and the boundary condition at the waveguide surface.

- The most widely configuration is a single solid dielectric cylinder of radius and refractive index n_1 .
- This cylinder is known as the core of the fiber.
- The core is surrounded by a solid dielectric material known as cladding with a refractive index n_2 ($< n_1$)
- Cladding is not for propagating light.

- The purposes of the core are:-
- To reduce scattering losses.
- It provides mechanical strength.
- It protects core from absorbing surface contaminants.
- The core of the standard optical fiber is made up of pure silica glass (SiO_2).
- The core is surrounded by a silica glass cladding.
- The fiber is encapsulated in an elastic plastic material.

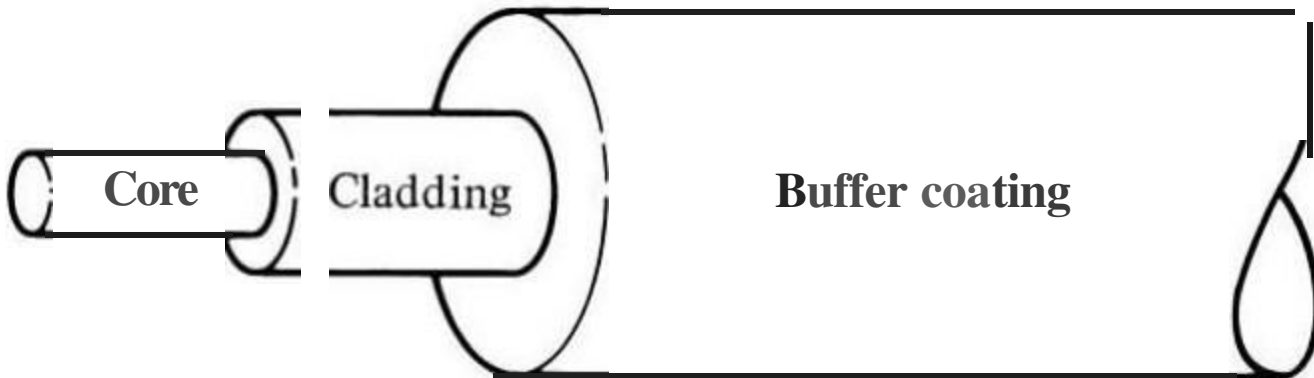


Fig. Single fiber structure

This plastic material is known as buffer coating.

- This material provides additional strength to the fiber.
- This also isolates the fibers from distortions or roughness of the adjacent surface.
- On the bases of the variations in the core material, we have two kind of optical fibers as shown in figure on next slide.

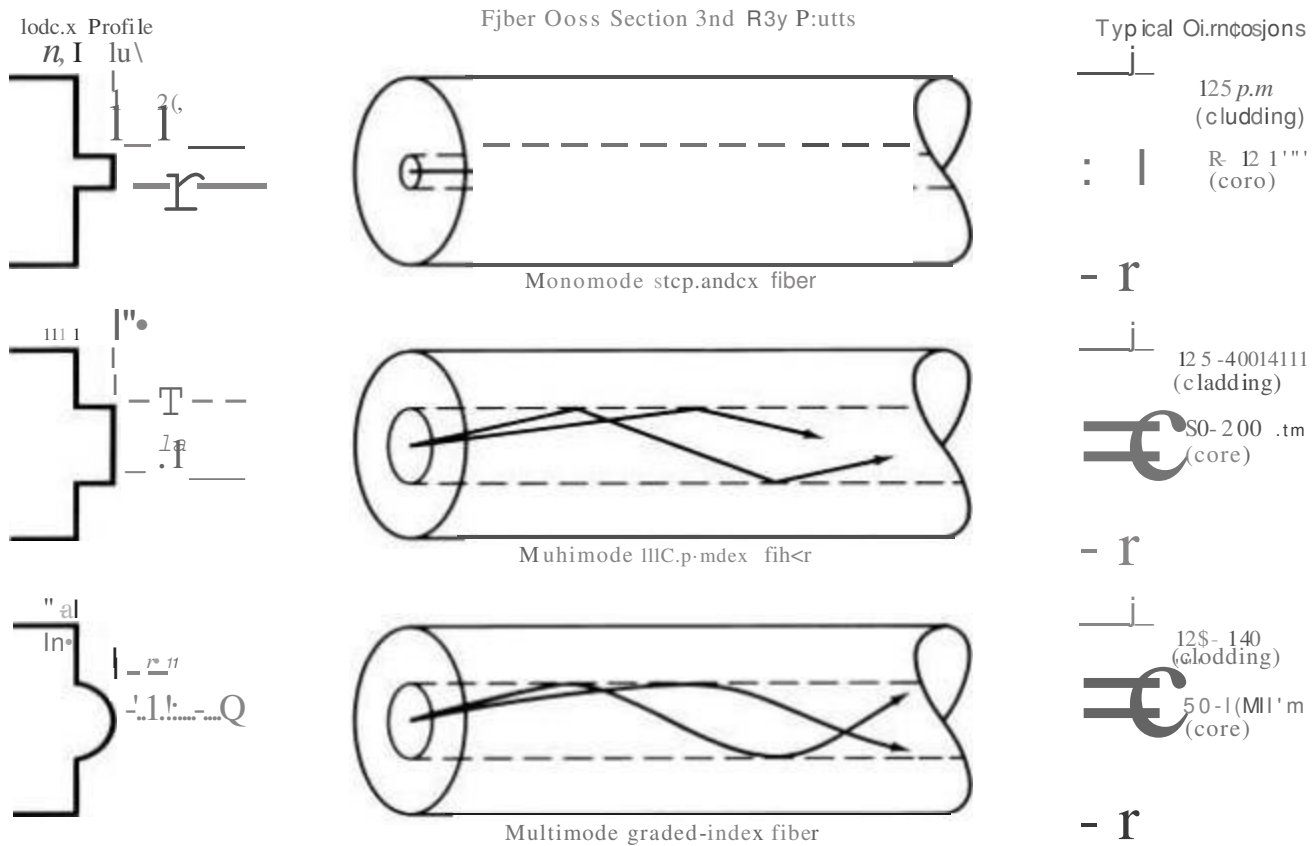


Fig. : Comparison of fiber structures

If the refractive index of the core is uniform throughout and if there is an abrupt change (step) at the cladding boundary, then this is called **step index fiber**.

If the refractive index of the core varies as a function of the radial distance (gradual) from the centre of the fiber, this is called **graded index fiber**.

Both the step index and graded index fibers can be further classified into single mode and multi mode fibers.

The single mode fibers contain only one mode of propagation, whereas multimode fibers contain many hundred modes.