FIBER-OPTIC CABLE

SUBJECT:DATA COMMUNICATION & OPTICAL FIBERS

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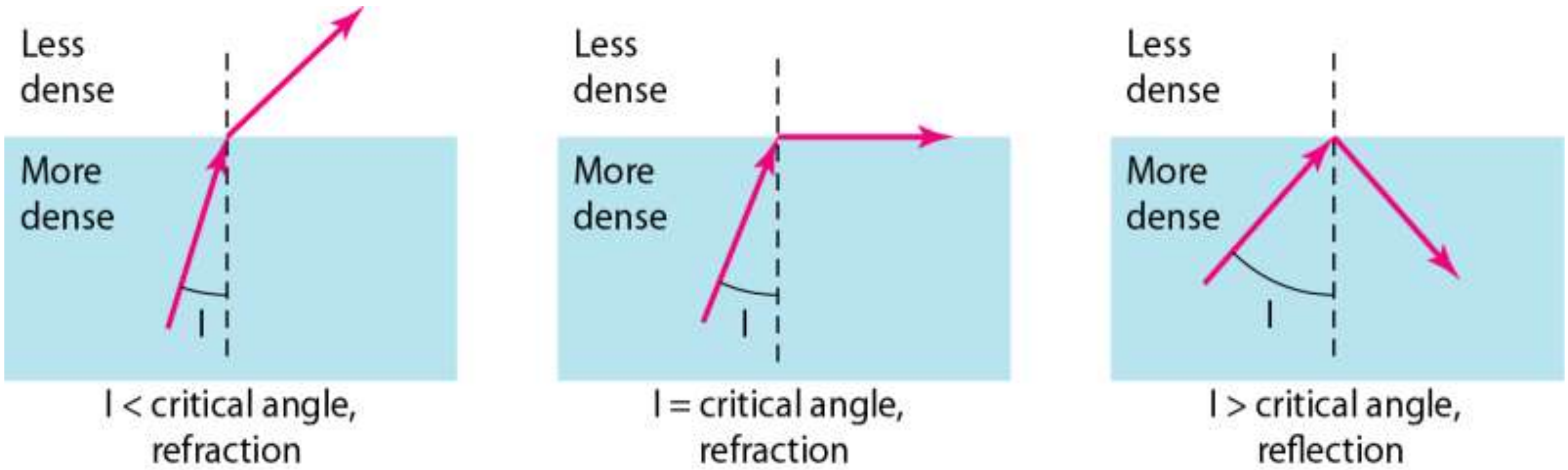
DEPT OF COMPUTER APPLICATION
2020-21

FIBER-OPTIC CABLE

- A fiber-optic cable is made of glass or plastic and transmits signals in the form of light.
- To understand optical fiber, we first need to explore several aspects of the nature of light.
- Light travels in a straight line as long as it is moving through a single uniform substance.
- If a ray of light traveling through one substance suddenly enters another substance(of a different density), the ray changes direction.
- Figure 7.10 shows how a ray of light changes direction when going from a more dense to a less dense substance.

Figure 7.10 *Bending of light ray*



- As the figure shows, if the angle of incidence *I (the arlgle the ray makes with the* line perpendicular to the interface between the two substances) is less than the critical angle, the ray refracts and moves closer to the surface.
- If the angle of incidence is equal to the critical angle, the light bends along the interface.
- If the angle is greater than the critical angle, the ray reflects (makes a turn) and travels again in the denser substance.
- Note that the critical angle is a property of the substance, and its value differs from one substance to another.

- Optical fibers use reflection to guide light through a channel.
- A glass or plastic core is surrounded by a cladding of less dense glass or plastic.
- The difference in density of the two materials must be such that a beam of light moving through the core is reflected off the cladding instead of being refracted into it.

Figure 7.11 *Optical fiber*

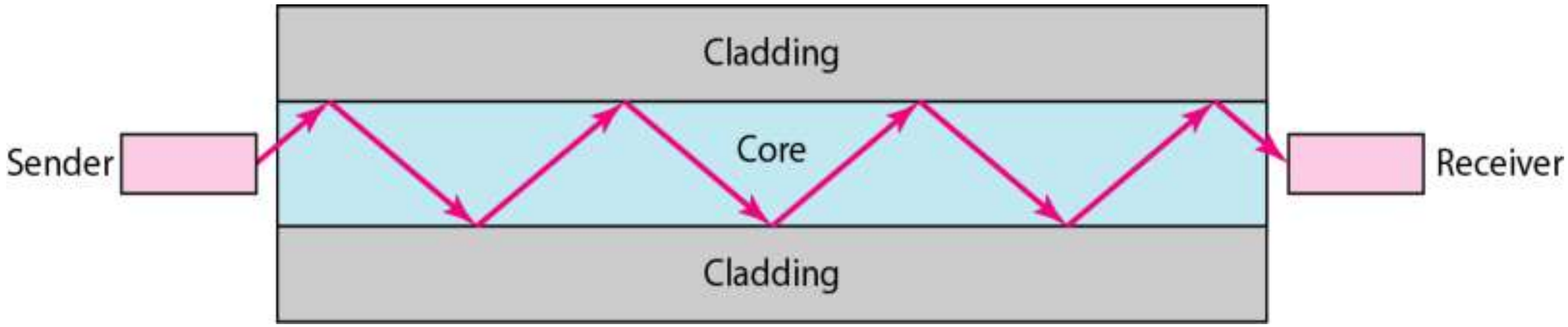
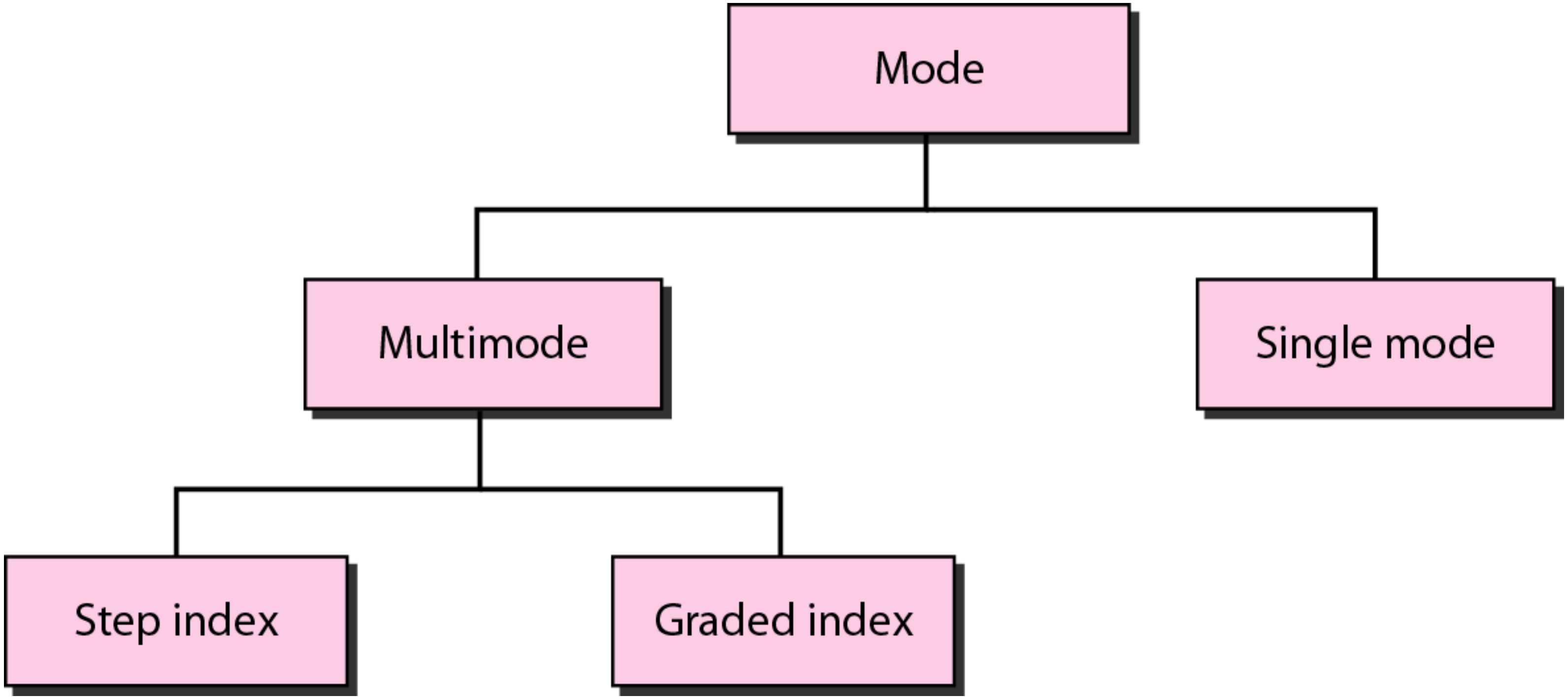


Figure 7.12 *Propagation modes*



PROPAGATION MODES

- Current technology supports two modes (multimode and single mode) for propagating light along optical channels, each requiring fiber with different physical characteristics.
- Multimode can be implemented in two forms: step-index or graded-index.

MULTIMODE

- Multimode is so named because multiple beams from a light source move through the core in different paths. How these beams move within the cable depends on the structure ofthe core, as shown in Figure 7.13.

- In multimode step-index fiber, the density of the core remains constant from the center to the edges. A beam of light moves through this constant density in a straight line until it reaches the interface of the core and the cladding.

- At the interface, there is an abrupt change due to a lower density; this alters the angle of the beam's motion.

- The term *step index refers to the suddenness of this change, which contributes to the distortion* of the signal as it passes through the fiber.

- A second type of fiber, called multimode graded-index fiber, decreases this distortion of the signal through the cable.
- The word *index here refers to the index of refraction*. As we saw above, the index of refraction is related to density.
- A graded-index fiber, therefore, is one with varying densities. Density is highest at the center of the core and decreases gradually to its lowest at the edge.
- Figure 7.13 shows the impact of this variable density on the propagation of light beams.

SINGLE-MODE

- Single-mode uses step-index fiber and a highly focused source of light that limits beams to a small range of angles, all close to the horizontal.

- The single mode fiber itself is manufactured with a much smaller diameter than that of multimode fiber, and with substantiallY lower density (index of refraction).

- The decrease in density results in a critical angle that is close enough to 90° to make the propagation of beams almost horizontal.

- In this case, propagation of different beams is almost identical, and delays are negligible. All the beams arrive at the destination "together" and can be recombined with little distortion to the signal (see Figure 7.13).

Figure 7.13 *Modes*

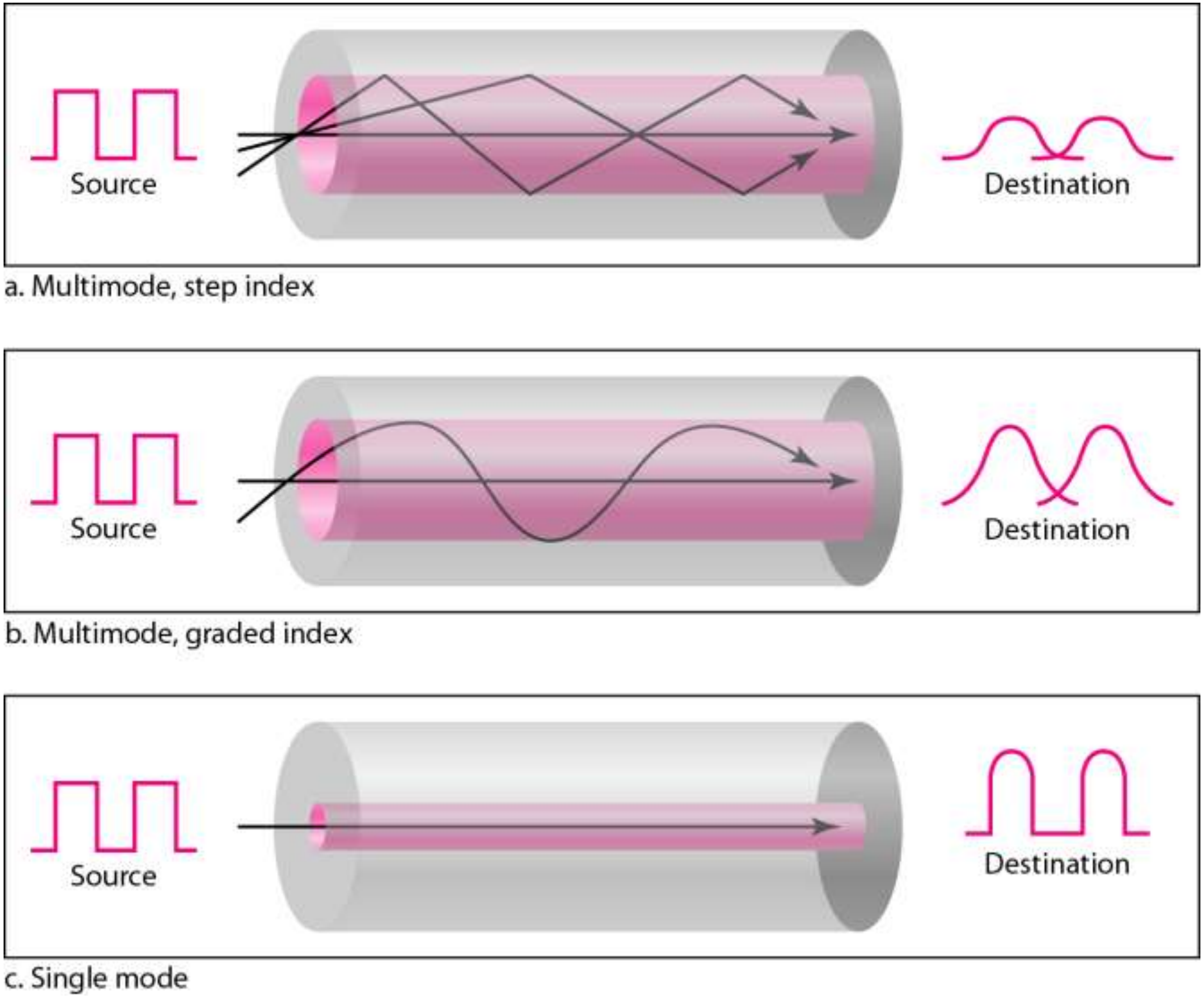


Table 7.3 *Fiber types*

Type	*Core (µm)*	*Cladding (µm)*	*Mode*
50/125	50.0	125	Multimode, graded index
62.5/125	62.5	125	Multimode, graded index
100/125	100.0	125	Multimode, graded index
7/125	7.0	125	Single mode

Figure 7.14 *Fiber construction*

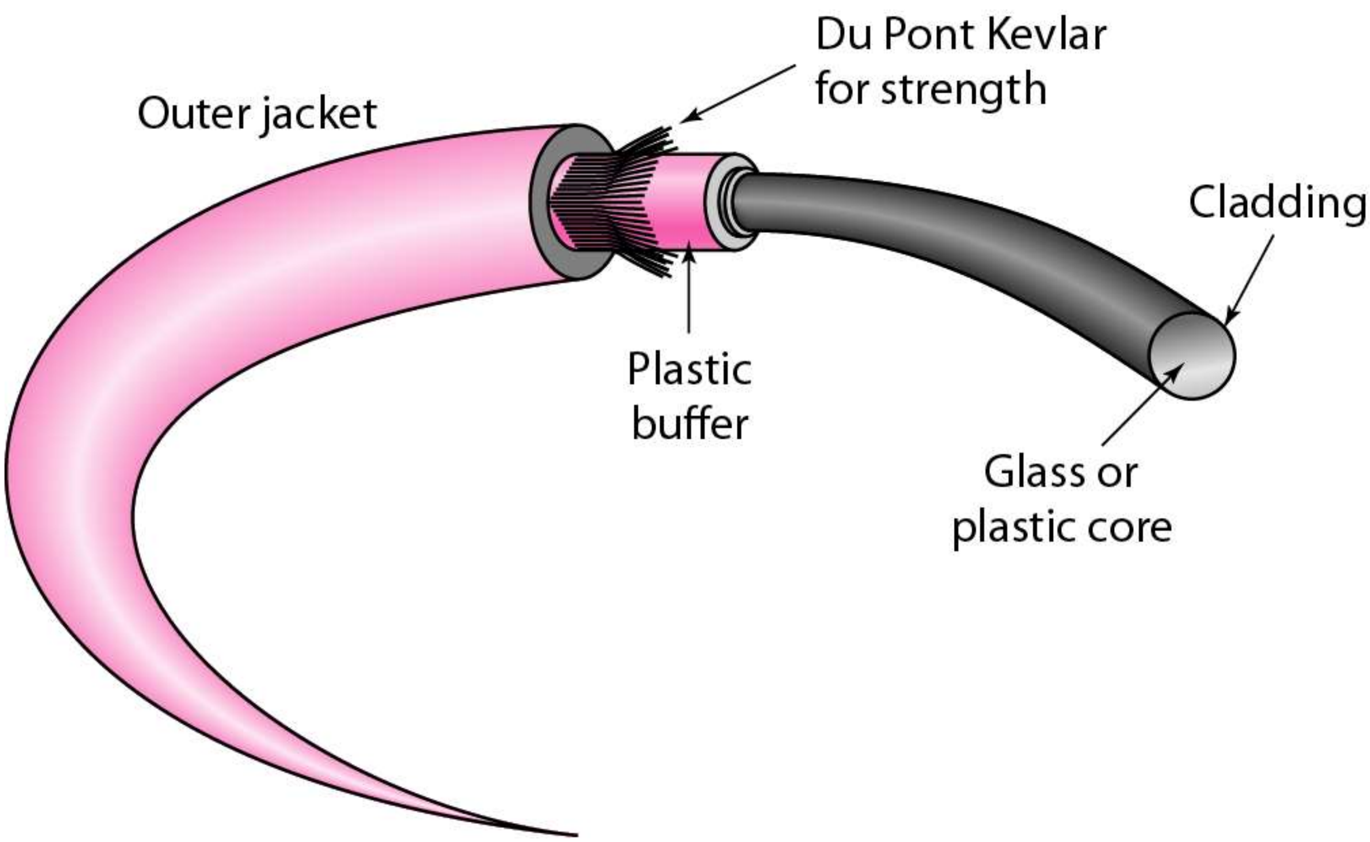


Figure 7.15 *Fiber-optic cable connectors*

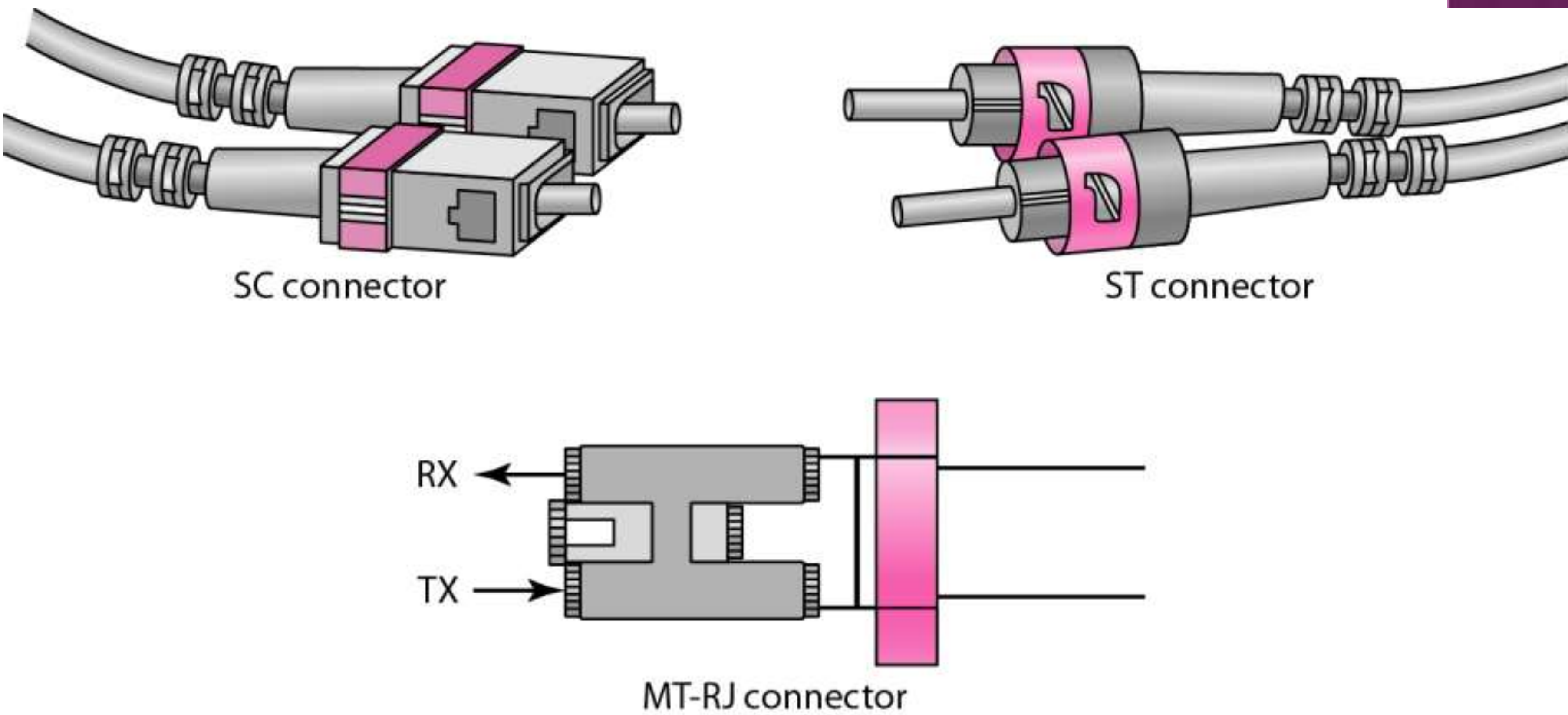


Figure 7.16 *Optical fiber performance*