



Princess Sumaya
University
for Technology

King Abdullah II School of Engineering

EE 23551
Optical Communications

Quiz #1
Tuesday 7/7/2026

Name:.....



Q.1) As illustrated in Figure 1, the reflected beam is shifted laterally from the trajectory predicted by simple ray theory analysis. Explain why the lateral shift d is needed.

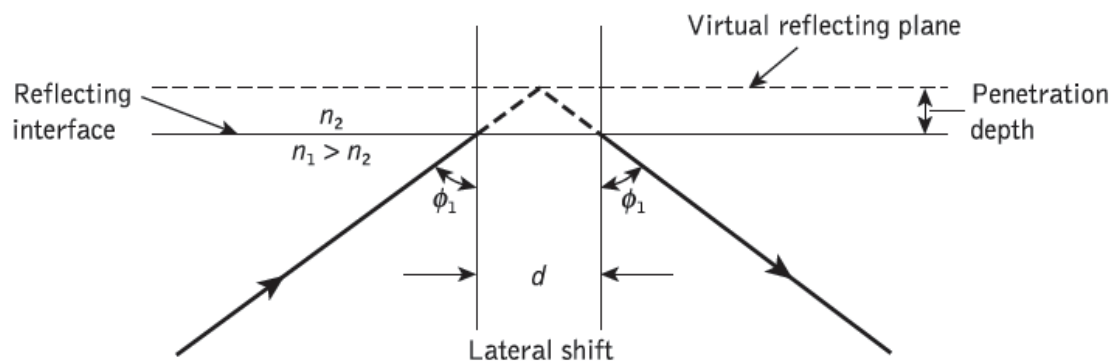


Figure 1

Solution: [6-Points]

Careful examination shows that the reflected beam is shifted laterally from the trajectory predicted by simple ray theory analysis, as illustrated in Figure 1.

This lateral displacement is known as the Goos-Haenchen shift (no need to mention this name), after its first observers. The geometric reflection appears to take place at a virtual reflecting plane which is parallel to the dielectric interface in the lower index medium, as indicated in Figure 1.

Q.2) Waveguide perturbations may change the propagation characteristics of the fiber, explain that in details.

Hint:

1. Deviations of the fiber axis from straightness.
2. Variations in the core diameter.
3. Irregularities at the core–cladding interface.
4. Refractive index variations.

Solution: [8-Points]

Waveguide perturbations may change the propagation characteristics of the fiber such as :

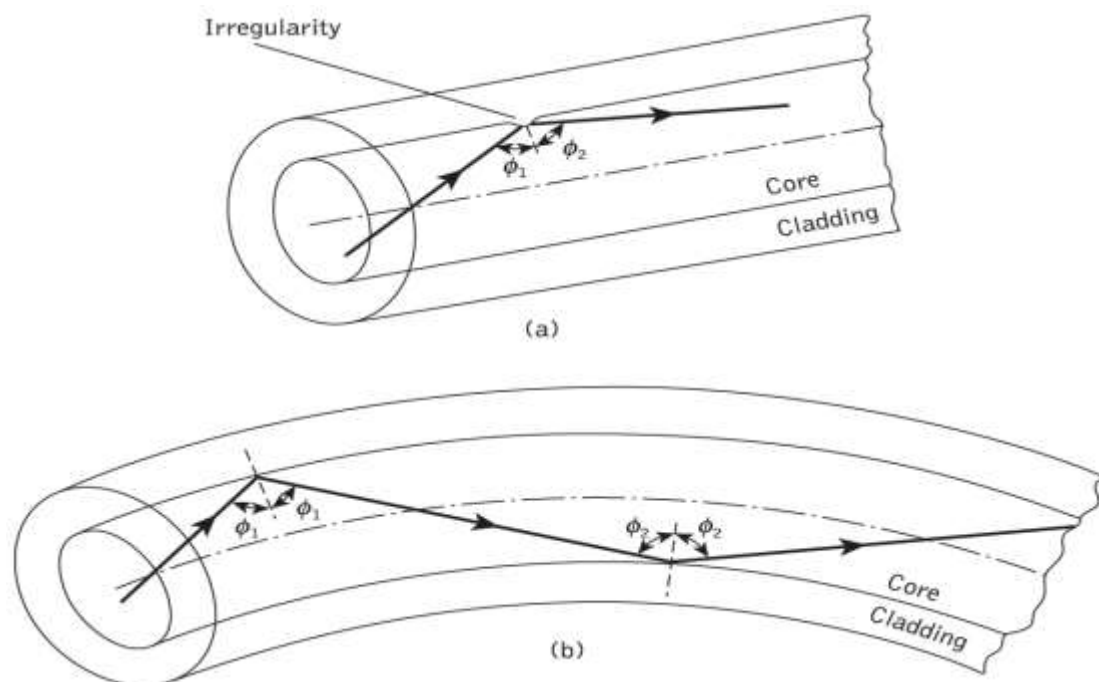
deviations of the fiber axis from straightness

variations in the core diameter

irregularities at the core–cladding interface

refractive index variations

These will have the effect of coupling energy traveling in one mode to another depending on the specific perturbation.



Q.3) It may be observed that the meridional rays shown in Figure 3 appear to follow curved paths through the graded index fiber core. Using the concepts of geometric optics, explain in details why the rays follow curved paths.

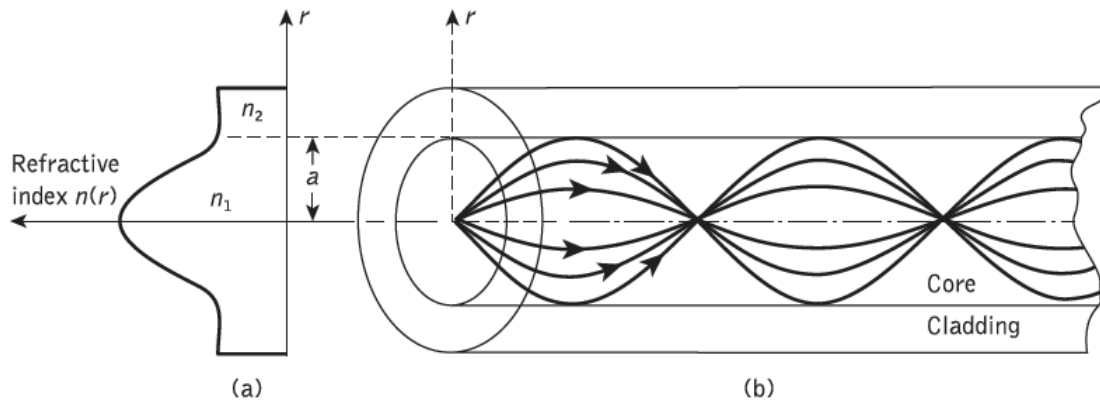


Figure 3

Solution: [6-Points]

It may be observed that the meridional rays shown appear to follow curved paths through the fiber core. Using the concepts of geometric optics, the gradual decrease in refractive index from the center of the core creates many refractions of the rays as they are effectively incident on a large number of high to low index interfaces.

This mechanism is illustrated in Figure 3 where a ray is shown to be gradually curved, with an ever-increasing angle of incidence, until the conditions for total internal reflection are met, and the ray travels back towards the core axis, again being continuously refracted.

