SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A++' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

OPTICAL AND MICROWAVE ENGINEERING

III YEAR/ VI SEMESTER

UNIT 4 – OPTICAL COMMUNCATION

TOPIC – OPTICAL FIBERS AND DEVICES-ACCEPTANCE ANGLE, NUMERICAL APERTURE

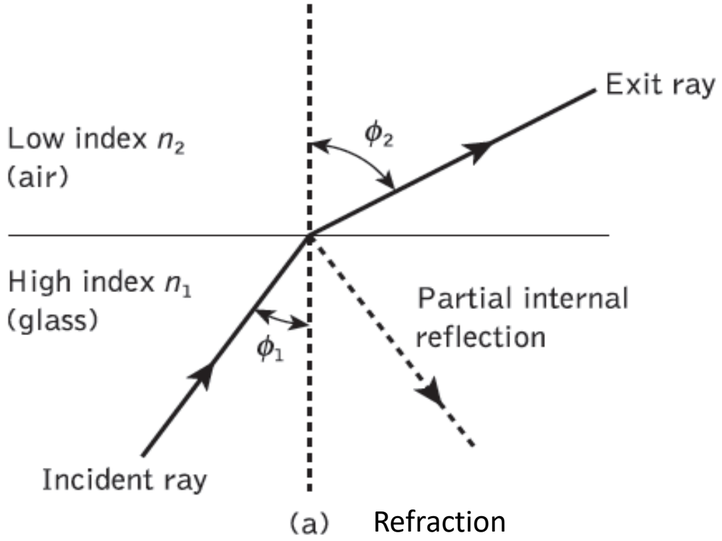
RAY THEORY TRANSMISSION

Total internal reflection

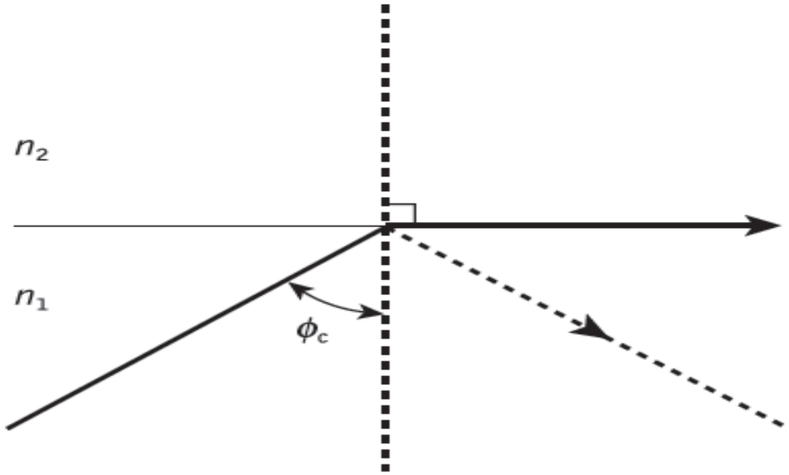
- **Refraction**
  - When a ray is incident on the interface between two dielectrics of differing refractive indices (e.g. glass – air) refraction occurs shown in Fig. a.
  - The angle of incidence $\phi 1$ and angle of refraction $\phi 2$ is related by Snell's law of refraction

$$n1 \sin\phi 1 = n2 \sin\phi 2 \quad \text{(or)}$$

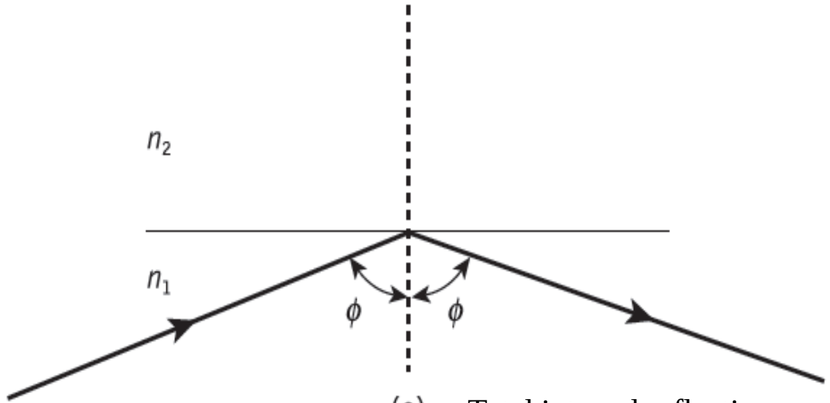
Refractive index of a medium = Velocity of light in a medium/ Velocity of light in a vacuum



(a) Refraction



(b) Limiting case of refraction- critical ray at angle ϕc



(c) Total internal reflection

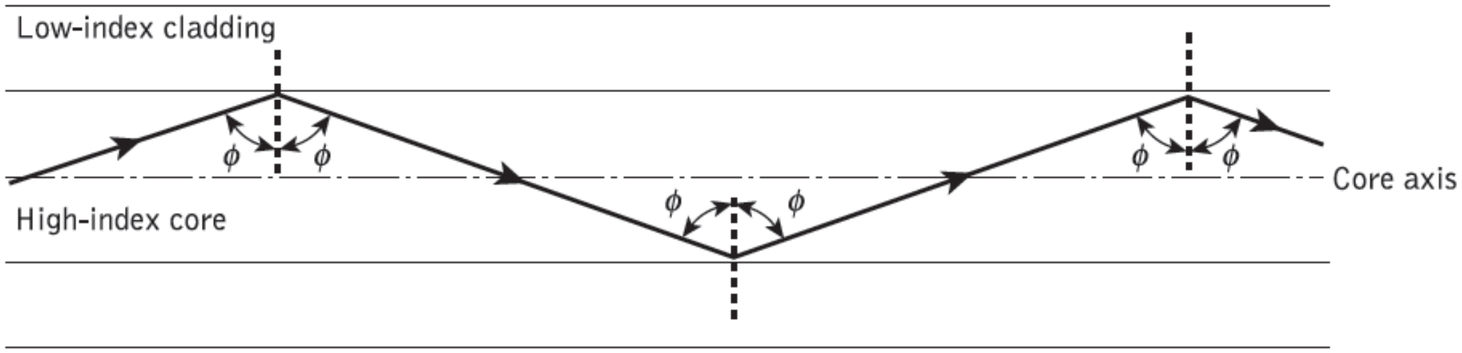
- Critical angle
- As n1 is greater than n2,the angle of refraction is always greater than the angle of incidence.
- Thus when the angle of refraction is 90° and the refracted ray emerges parallel to the interface between the dielectrics, the angle of incidence must be less than 90°. This is the limiting case of refraction and the angle of incidence is now known as the critical angle φc (Fig. b),

$$\sin \phi_c = \frac{n_2}{n_1}$$

- Total internal reflection
- When light is incident on the dielectric of lower index from the dielectric of higher index an at angles of incidence greater than critical angle. (Fig. c)

Propagation of light wave through Optical fiber

- Any light wave which travels along the core and meets the cladding at the critical angle of incidence will be totally internally reflected. Therefore light wave is propagated along the fiber core by a series of total internal reflections.



Acceptance angle

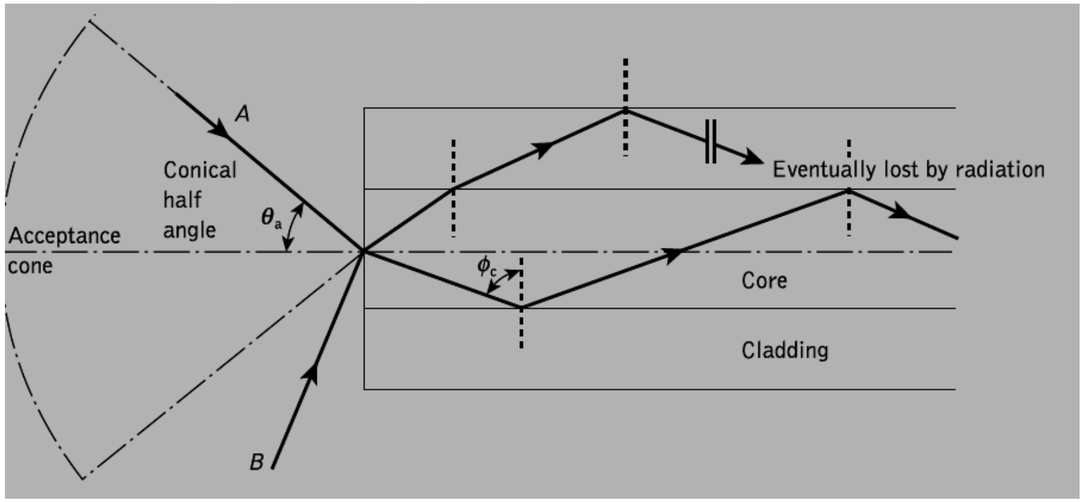
Acceptance angle

✓Meridional ray A enters the fiber core at an angle θa.

✓Incident ray b at an angle greater than θa is refracted into the cladding an eventually lost by radiation.

✓An acceptance angle defined by the conical half angle θa.

✓ θa is the maximum angle to the axis at which light may enter the fiber in order to be propagated is called acceptance angle for the fiber.



Numerical Aperture (NA)

✓Numerical aperture of the fiber is the light collecting efficiency of the fiber and is the measure of the amount of light rays that can be accepted by the fiber. It is equal to the sine of acceptance.

$$\mathbf{NA = n_0 \sin \theta a = (n_1^2 - n_2^2)^{1/2}}$$

where, n_1 and n_2 are the refractive indices of core and cladding respectively.

✓Numerical aperture of step index fiber is given as

$$\mathbf{NA = n_1 \sqrt{2\Delta}}$$

THANK YOU