18PYB101J MODULE-5

LECTURE 10

- **Solving Problems**

1. Two layers of glass are placed on top of each other. The light is travelling from n = 1.45 to n = 1.40. Find the range of angles θ, for which total internal reflection takes place.

$n_1 = 1.45$ *and* $n_2 = 1.40$.

We know that $\theta_c = \sin^{-1}\left(\frac{n_2}{n_1}\right)$

Substituting the values of n_1 *and* n_2

$\theta_c = \sin^{-1}\left(\frac{1.4}{1.45}\right)$ *74.9°*

Thus, for the critical case $\theta_x = 90 - 74.9 = 15.1°$, *and for all angles* θ_x *less than 15.1°, total internal reflection takes place.*

2. A fiber has the following characteristics: n_1 = 1.35 (core index) and Δ =2%. Find the N.A and the acceptance angle.

n_1 = 1.35 ; Δ = 2% = 0.02

W.K.T $N.A = n_1 \times (2\Delta)^{1/2}$

$= 1.35 \times (2 \times 0.02)^{1/2} = 0.27$

$\theta_a = \sin^{-1}(\text{N.A}) = \sin^{-1}(0.27) = 15.66°$

Acceptance angle = $2\theta_a$ = 31.33°

3. A silica optical fiber has a core refractive index of 1.50 and a cladding refractive index of 1.47. Determine (i) the critical angle at the core – cladding interface, (ii) the N.A for the fiber and (iii) the acceptance angle for the fiber. $n_1 = 1.50\ ;\ n_2 = 1.47$

The critical angle $\theta_c = \sin^{-1}\left(\frac{n_2}{n_1}\right) = \sin^{-1}\left(\frac{1.47}{1.50}\right) = 78.5^\circ$

The numerical aperture $N.A = (n_1^{\ 2} - n_2^{\ 2})^{1/\ 2}$

$(1.50^2 - 1.47^2)^{1/\ 2} = 0.30$

The acceptance angle $= 2\theta_a = 2 \sin^{-1}(N.A) = 2 \sin^{-1}(0.30) = 34.9°$

Critical angle = 78.5º ; N.A = 0.30 ; Acceptance angle = 34.9°

4. Calculate the numerical aperture and acceptance angle of fiber with a core index of 1.52 and a cladding index of 1.50.

Hint: $n_1 = 1.52$; $n_2 = 1.50$

$N.A = (n_1^2 - n_2^2)^{1/2} = 0.246$ **and**

$\theta_a = \sin^{-1}(N.A) = 14°14';$

Acceptance angle $= 2\theta_a = 28°28'$