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Physics - 2 (15B11PH212)

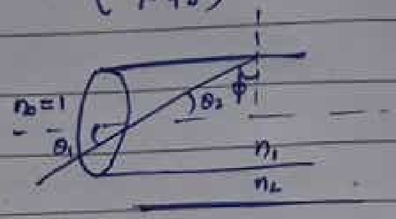
Tutorial - 7

Q.1. for TIR $\mu_1(\text{core}) > \mu_2(\text{cladding})$, $\theta_c = \sin^{-1}\left(\frac{n_2}{n_1}\right)$

Q.2. (a) $n_1 = 1.48$, $n_2 = 1.44$

$$\theta_c = \sin^{-1}\left(\frac{n_2}{n_1}\right) = \sin^{-1}\left(\frac{1.44}{1.48}\right) \approx 76.65^\circ$$

(b) $\phi > \phi_c$



$$\theta_2 = 90 - \phi_c$$
$$= 90 - 76.65$$
$$= 13.35^\circ$$

$\theta_2 < 13.35^\circ$ Angle of propogation.

(c) for θ_1 either $n_0 \sin\theta_1 = n_1 \sin\theta$

$$\sin\theta_1 = n_1 \sin\theta$$
$$\theta_1 < 1.48 \sin(13.35^\circ)$$
$$\theta_1 < 20^\circ$$

$$NA = \sin\theta_1 = \sqrt{n_1^2 - n_2^2} = \sqrt{2.1904 - 2.0730}$$
$$\theta_1 \approx 20^\circ$$

So Acceptance Angle or incidence Angle $< 20^\circ$

(d) yes.

Q.3. $n_1 = 1.5$, fraction diff $\Delta = 0.005$

$$\Delta = \frac{n_1 - n_2}{n_1} \Rightarrow n_2 = 1.4925$$

$$NA = \sqrt{n_1^2 - n_2^2} = \sqrt{2.25 - (1.49)^2} \approx 0.15$$

$$NA = \sin i \rightarrow i = \sin^{-1}(0.15) = 8.64^\circ$$

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Q.4. $V = \frac{\pi d \times NA}{\lambda} = \frac{\pi d \sqrt{n_1^2 - n_2^2}}{\lambda} = \frac{3.14 \times 50 \times 10^{-6} \sqrt{(1.54)^2 - (1.5)^2}}{1500 \times 10^{-9}}$

$= 36.4$ Ans

no. of grades $= \frac{V^2}{2} = 662$ Ans

Q.5. $NA = \sqrt{n_1^2 - n_2^2} = 0.348$

Acceptance Angle $i = \sin^{-1}(NA) = 20.4^\circ$ Ans

for steepest angle $\phi = \phi_c = \sin^{-1}\left(\frac{n_2}{n_1}\right) = \sin^{-1}(0.974) = 76.9^\circ$ Ans

$x = d \tan\phi_c = 50 \times 10^{-6} \tan(76.9) = 215.07 \mu m$

NO. of reflection per meter $N = \frac{1}{215.07 \times 10^{-6}} \approx 4650$ reflection

Q.6. $V = \frac{\pi d \sqrt{n_1^2 - n_2^2}}{\lambda}$ $V = 2.405$ for single mode.

$\lambda = \frac{\pi d \, NA}{V} \longrightarrow \frac{\lambda_1}{\lambda_2} = \frac{d_1}{d_2}$

% change in core diameter

$\frac{d_1 - d_2}{d_1} = \frac{\lambda_1 - \lambda_2}{\lambda_1} \times 100 = \frac{1.2 - 0.63}{1.2} \times 100 \approx 47.5\%$

Q.7. loss/KM in dB $= \frac{10}{L} \log_{10} \frac{P_{out}}{P_{in}}$

$= -10 \log\left(\frac{25}{100}\right) \cdot \frac{1}{0.5}$

$= 20(2 - 1.39) \cong 12.042$ dB/KM Ans