

Name:

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KEY

A $7\ \mu\text{m}$ thick symmetric slab waveguide has a core refractive index of 1.46. The critical angle at the core-cladding boundary equals 75° . The source wavelength is $1.3\ \mu\text{m}$.

- Calculate the number of guided TE modes.
- Find the maximum core thickness which ensures single mode operation of the slab waveguide.
- Find the range of core thickness which ensures that the slab waveguide supports exactly three guided TE modes.

$$a) \quad \sin \theta_c = \frac{n_2}{n_1} \Rightarrow (\sin 75^\circ)(1.46) = n_2 = 1.41025$$

$$V = \frac{2\pi}{\lambda} d \sqrt{n_1^2 - n_2^2} = \frac{2\pi}{1.3} \times 3.5 \times \sqrt{(1.46)^2 - (1.41025)^2}$$

$$= 6.3924$$

$$N = \text{int} \left(\frac{2V}{\pi} \right) + 1 = \text{int} \left(\frac{2 \times 6.3924}{\pi} \right) + 1 = 4 + 1 = 5$$

TE modes

$$b) \quad V < \frac{\pi}{2}$$

$$\frac{2\pi}{1.3} d_{\max} \sqrt{(1.46)^2 - (1.41025)^2} = \frac{\pi}{2}$$

$$d_{\max} = 0.86\ \mu\text{m} \Rightarrow 2d_{\max} = 1.72\ \mu\text{m}$$

$$c) \quad \pi < V < \frac{3\pi}{2}$$

$$3.44\ \mu\text{m} < 2d_{\max} < 5.16\ \mu\text{m}$$