#1 - 8 - through recorded video
+ pdf document

solving now :

#9 $P_{in} = 2\,mW$, $P_{out} = 20\,\mu m$, $L = 50\,km$

$$\alpha = \frac{10}{L} \log\left(\frac{P_{in}}{P_{out}}\right) \text{ ; L in km}$$

$$= \frac{10}{50} \log\left(\frac{2\times10^{-3}}{20\times10^{-6}}\right)$$

$$= 0.4 \text{ dB/km}$$

(10) $\alpha = 0.2\ dB/Km, \quad L = ?$

$P_{out} = 10\%\ \text{of}\ P_{in} = 0.1\ P_{in}$

$$\alpha = \frac{10}{L} \log\left(\frac{P_{in}}{P_{out}}\right)$$

$$\alpha = \frac{10}{L} \log\left(\frac{P_{in}}{0.1\ P_{in}}\right) = \frac{10}{L} \log(10)$$

$$\Rightarrow \quad \alpha = \frac{10}{L} \quad \Rightarrow L = \frac{10}{\alpha} = \frac{10}{0.2}$$

$L = 50\ Km$

(11) $n_1 = 1.46$, $\Delta = 0.015$, $L = 1500\,m$

$$\tau_i = \frac{n_1 \Delta L}{c} = \frac{1.46 \times 0.015 \times 1500}{3 \times 10^8}$$

$$= 1.095 \times 10^{-7}\,s \quad \text{or} \quad 109.5\,ns$$

$$\frac{\tau_i}{L} = \frac{n_1 \Delta}{c} = \frac{1.095 \times 10^{-7}}{1500} = 7.3 \times 10^{-11}\,s/m$$

$$= 7.3 \times 10^{-11} \times 10^{12}\,ns/Km$$

$$= 73\,ns/Km$$

(12) $n_1 = 1.5$, $\Delta = 0.01$ (graded index fibre)

$$\Delta = \frac{n_1 - n_2}{n_1} \Rightarrow n_2 = n_1(1-\Delta)$$

$$n_2 = 1.5(1-0.01) = 1.485$$

$$\frac{\tau_i}{L} = \frac{n_2 \Delta^2}{2c} = \frac{1.485 \times (0.01)^2}{2 \times 3 \times 10^8}$$

$$= 2.475 \times 10^{-13} \text{ s/m}$$

$$= 2.475 \times 10^{-13} \times 10^{12} \text{ ns/km}$$

$$= 0.247 \text{ ns/km}$$

(13) $\alpha_f = 0.2\ dB/Km$, $L = 10\ Km$, $P_{in} = 5\ mW$, $\alpha_c = 1\ dB$

w/o connecters :

$$\alpha_f = \frac{10}{L} \log\left(\frac{P_{in}}{P_{out}}\right) \Rightarrow \frac{P_{in}}{P_{out}} = 10^{\alpha L/10}$$

$$\therefore P_{out} = \frac{P_{in}}{10^{\alpha L/10}} = \frac{5}{10^{0.2\times 10/10}} = \frac{5}{10^{0.2}}$$

$$= 3.15\ mW$$

with connecters :

total loss factor : total loss offered by 10 Km long fibre

+ loss offered by connected

$$\alpha_t L = \alpha_f \cdot L + 2 \cdot \alpha_c$$

$$= 0.2 \times 10 + 2 \times 1$$

$$= 4 \text{ dB} \quad (\text{not dB/Km})$$

$$\alpha_t \cdot L = 10 \log \left(\frac{P_{in}}{P_{out}'} \right)$$

$$\therefore P_{out}' = \frac{P_{in}}{10^{\alpha_t L/10}} = \frac{5}{10^{4/10}} = \frac{5}{10^{0.4}}$$

$$= 1.99 \simeq 2 \text{ mW}$$

$$\therefore \% \text{ decrease in o/p power} = \frac{P_{out} - P_{out}'}{P_{out}} \times 100\% = \frac{3.15 - 2}{3.15} \times 100\% = 36.5\%$$

(14) $n_1 = 1.46$, $n = 1.42$ $\Rightarrow$ $\Delta = \frac{n_1 - n_2}{n_1} = \frac{1.46 - 1.42}{1.46}$

$\tau_m = 1.7$ ns/km

$= 0.027$

$L = 2$ Km

$\Rightarrow$ τ_m total $= 1.7 \times 2 = 3.4$ ns

$$\tau_i (SI) = \frac{n_1 L \Delta}{c} = \frac{1.46 \times 2000 \times 0.027}{3 \times 10^8} = 2.628 \times 10^{-7} s$$

$$= 262.8 \text{ ns}$$

$$\tau_i (GRIN) = \frac{n_2 L \Delta^2}{2c} = \frac{1.42 \times 2000 \times (0.027)^2}{2 \times 3 \times 10^8} = 3.45 \times 10^{-9} s$$

$$= 3.45 \text{ ns}$$

total dispersion

$$\tau(SI) = \sqrt{\tau_i^2(SI) + \tau_m^2} \simeq \tau_i(SI) \quad \text{as } \tau_i(SI) >> \tau_m$$

$$\simeq 262.8 \text{ ns}$$

$$\therefore B(SI) = \frac{0.7}{\tau} = \frac{0.7}{262.8 \times 10^{-9}} \simeq 2.66 \times 10^6 \text{ bits/sec}$$

$$= 2.66 \text{ MBPS}$$

$$\tau(GRIN) = \sqrt{\tau_i^2(GRIN) + \tau_m^2} = \sqrt{3.45^2 + 3.4^2} \simeq 4.84 \text{ ns}$$

$$B(GRIN) = \frac{0.7}{\tau} = \frac{0.7}{4.84 \times 10^{-9}} = 144.6 \times 10^6 \text{ bits/sec}$$

$$= 144.6 \text{ MBPS}$$

SM → 206 MBPS