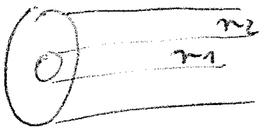
SOLUZIONE ESERCIZIO 1

TERZA FINESTRA $\lambda_0 = 1550\ nm$



$n_1 = 1,45$ $D_m = 12 \frac{ps}{nm \cdot km}$

$n_2 = 1,44$ $D_W = -5 \frac{ps}{nm \cdot km}$

a) perché la fibra sia monomodale è necessario che $V < 2,405$

$$\frac{2\pi a}{\lambda}\sqrt{n_1^2 - n_2^2} < 2,405$$

$$a < \frac{2,405 \cdot \lambda_0}{2\pi\sqrt{n_1^2 - n_2^2}} = 3,4899\ \mu m \simeq 3,49\ \mu m$$

$\hookrightarrow d = 2a < 6,979\ \mu m$

SCELGO AD ESEMPIO $d = 6,5\ \mu m$

b) $B_{max} = 50\ Mbit$ CODIFICA RTZ

$$B_{RTZ} = \frac{1}{2\Delta\tau_{TOT}}$$

$$\Delta\tau_{TOT} \leq \frac{1}{2B_{NRZ}} = 10\ ns$$

$$\Delta\tau_{TOT}^2 = \Delta\tau_{FIBRA}^2 + t_{r_{LED}}^2 + t_{r_{RIV}}^2$$

(2)

$$\Delta\tau_{FIBRA}^2 = \Delta\tau_{TOT}^2 - t_{rLD}^2 - t_{rRIV}^2$$

$$\Delta\tau_{FIBRA} = \sqrt{\Delta\tau_{TOT}^2 - t_{rLD}^2 - t_{rRIV}^2} = |D_m + D_W| \Delta\lambda L$$

$$|D_m + D_W| \Delta\lambda_{FWHM} \cdot L \le \sqrt{\underbrace{\Delta\tau_{TOT}^2 - t_{rLD}^2 - t_{rRIV}^2}_{8,6\,ns}}$$

$$L \le 24,57\,km$$

(c) $P_0 = 10\,mW \rightarrow P_0|_{dBm} = 10\log_{10}\left(\frac{P_0}{1\,mW}\right) = 10\,dBm$

SCELGO N=24 SPEZZONI

$$\alpha_{FIBRA} = 0,3\,\frac{dB}{km} \cdot L = 7,2\,dB$$

$$\alpha_{GIUNZIONI} = (N-1) \cdot 1\,dB = 23\,dB$$

$$P_{OUT}|_{dBm} = -20,2\,dBm$$

$$P_{OUT} = 9,55\,\mu W$$

SOLUZIONE ESERCIZIO 2

a) $P_0 = \eta_{slope} (I - I_{TH}) \rightarrow I_{TH} = I - \frac{P_0}{\eta_{slope}} = 10 mA$

b) PARTENDO DAL REGIME DI FUNZIONAMENTO STAZIONARIO SCRIVIAMO L'EQUAZIONE DI BILANCIO

$$\frac{I}{qLWt} = \frac{n}{\tau_r} + c\, n\, N_{PH}$$

IN CONDIZIONE SOPRA SOGLIA TROVIAMO

$$N_{PH} = \frac{\tau_{PH}}{qLWt} (I - I_{TH})$$

$$\tau_{PH} = \frac{n}{\alpha_T c}$$ con α_T le perdite totali

$$\alpha_T = \alpha_S + \frac{1}{2L} \ln\left(\frac{1}{R_1 R_2}\right)$$

$$R_1 = R_2 = \left(\frac{n_1 - n_0}{n_1 + n_0}\right)^2 = 0,3194$$

$$m \frac{\lambda}{2n} = L \rightarrow L = \frac{\lambda^2}{2n\Delta\lambda} = 80,27\ \mu m$$

$$\alpha_T = 157,18\ cm^{-1} = 15718\ m^{-1}$$

4

$$T_{PH} = \frac{n}{2\tau C} = 0,76\ ps$$

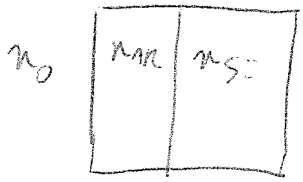
$$N_{PH} = 7,129 \cdot 10^{15}\ cm^{-3}$$

c) A SOGLIA POSSIAMO SCRIVERE

$$\frac{I_{TH}}{qLWt} = \frac{n_{TH}}{T_r}$$

$$\hookrightarrow n_{TH} = \frac{I_{TH} \cdot T_r}{qLWt} = 3,17 \cdot 10^{15}\ cm^{-3}$$

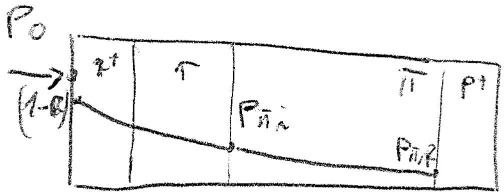
a) $n_{Si} = \sqrt{\varepsilon_r} = 3{,}42$



$$R = \left(\frac{n_0 n_{Si} - n_{AR}^2}{n_0 n_{Si} + n_{AR}^2} \right)^2 = 4{,}25\,\%$$

$$T = 1 - R = 95{,}75\,\%$$

b) CHIAMO η_{π} la frazione di potenza assorbita in π



$$\eta_{\pi} = \frac{P_{\pi i} - P_{\pi f}}{P_0}$$

$$\eta_{\pi} = \frac{P_0(1-R)\, e^{-\alpha(W_{n^+} + W_p)} - P_0(1-R)\, e^{-\alpha(W_{n^+} + W_p + W_{\pi})}}{P_0} =$$

$$= (1-R)\, e^{-\alpha(W_{n^+} + W_p)} \left(1 - e^{-\alpha W_{\pi}}\right) = 0{,}8838 \cdot 0{,}917975$$

$$= 0{,}811$$

c)

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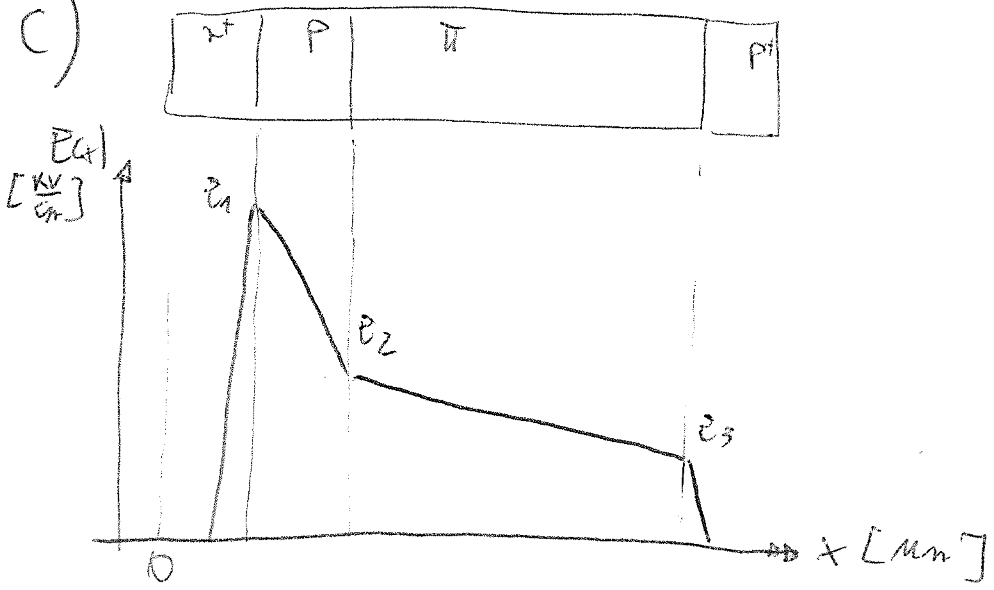

$$E_1 - E_2 = \frac{q N_{Adv}}{\varepsilon_{Si}} \cdot W_{Pdv} = 77{,}321 \frac{kV}{cm}$$

$$E_2 = E_1 - \frac{q N_{Adv}}{\varepsilon_{Si}} \cdot W_{Pdv} = 222{,}68 \frac{kV}{cm}$$

$$E_3 = E_2 - \frac{q N_{A\pi}}{\varepsilon_{Si}} \cdot W_{\pi} = 222{,}68 \frac{kV}{cm} - 193{,}3 \frac{kV}{cm} = 29{,}38 \frac{kV}{cm}$$

$$\phi_{Bi} \approx 1V$$

$$V_{Rov} = \frac{W_P (E_1 + E_2)}{2} + \frac{W_\pi (E_3 + E_2)}{2} - \phi_{Bi} =$$

$$= 13V + 315V - 1 = 327V$$