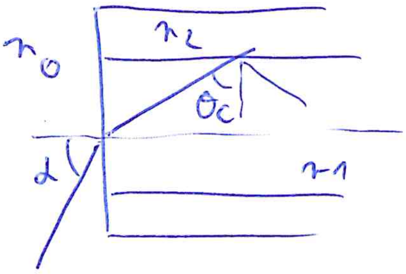
# SOLUZIONE ESERCIZIO FIBRA

1) LA LEGGE DI SNELL IMPONE CHE

$$n_0 \sin(\alpha) = n_1 \sin(\alpha_1) = n_1 \sin(90-\theta_c) = n_1 \cos(\theta_c)$$




PER TIR:

$$\sin(\theta_c) = \frac{n_2}{n_1}$$

DI CONSEGUENZA:

$$n_0 \sin(\alpha) = n_1 \cos(\theta_c) = n_1\sqrt{1-\sin^2(\theta_c)} = n_1\sqrt{1-\left(\frac{n_2}{n_1}\right)^2}$$

$$= \sqrt{n_1^2 - n_2^2} = NA$$

QUINDI

$$\alpha = \arcsin(NA) \simeq 11{,}79°$$

2) $n_2 = \sqrt{n_1^2 - NA^2} \simeq 1{,}385$

DISPERSIONE INTERMODALE:

$$\Delta t = \frac{L}{c}(n_1 - n_2) = 0{,}5\ \mu s \rightarrow f_{max} = 2\ MHz$$

3) $V = \frac{2\pi r}{\lambda} NA < 2{,}405 \rightarrow r < 249\ \mu m$

SOLUZIONE ESERCIZIO DIODO LASER

a)

$$\tau_{PH} = \frac{n}{C\alpha_T} \rightarrow \alpha_T = \frac{n}{C\tau_{PH}} = 5217{,}4\ m^{-1}$$

$$\alpha_S = \alpha_T - \frac{1}{2L} \ln\left(\frac{1}{R_1R_2}\right)$$

$$R_1 = R_2 = R = \left(\frac{3{,}6-1}{3{,}6+1}\right)^2 = 32\%$$

$$\alpha_S = 1541{,}8\ m^{-1}$$

b) PARTIAMO DALL'EQUAZIONE DI BILANCIO

$$\frac{I}{qLWd} = \frac{n}{\tau_r} + C\, n\, N_{PH}$$

A SOGLIA TRASCURIAMO EMISSIONE STIMOLATA $\rightarrow N_{PH} \sim 0$

$$\frac{I_{TH}}{qLWd} = \frac{n_{TH}}{\tau_r} \rightarrow I_{TH} = \frac{n_{TH}}{\tau_r} qLWd = 13{,}6\ mA$$

c)
$$P_0 = \frac{\frac{1}{2} N_{PH} \cdot \text{VOLUME} \cdot \text{ENERGIA}}{\Delta t}(1-R)$$

RICAVIAMO $N_{PH}$

$$I > I_{TH} \quad \begin{cases} n = n_{TH} \\ \dfrac{N_{PH}}{\tau_{PH}} = C\, n_{TH} N_{PH} \end{cases}$$

$$\frac{I}{qLWd} = \frac{n_{TH}}{\tau_r} + C\,n_{TH} N_{PH} = \frac{n_{TH}}{\tau_r} + \frac{N_{PH}}{\tau_{PH}}$$

$$\frac{n_{TH}}{\tau_r} \rightarrow \frac{I_{TH}}{qLWd}$$

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

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

quindi:

$$P_0 = \underbrace{\frac{1}{2}\,\frac{\tau_{PH}}{q}\,\frac{hc}{\lambda}\cdot\frac{c}{n}\cdot\frac{1}{L}}_{\eta_{slope}}(1-R)(I - I_{TH})$$

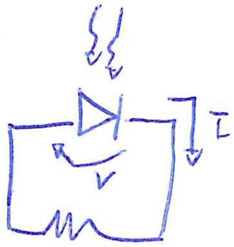
$$\eta_{slope} = \frac{hc^2\,\tau_{PH}(1-R)}{2q\lambda n L} = 0{,}3\,\frac{W}{A}$$

se $I = 50\ mA$

$$P_0 = \eta_s (I - I_{TH}) = 10{,}92\,mW$$

# SOLUZIONE ESERCIZIO CELLA SOLARE

a)




$R = 20\,\Omega$

$$I = -I_{PH} + I_{DIODO} = -I_{PH} + I_0\left(e^{\frac{V}{V_{TH}}} - 1\right)$$

per $V_{OC} \rightarrow I = 0$

$$-I_{PH} + I_0\left(e^{\frac{V}{V_{TH}}} - 1\right) = 0$$

se assumo $\underset{25{,}8\,mV}{V_{OC} \gg V_{TH}} \Rightarrow e^{\frac{V_{OC}}{V_{TH}}} = \frac{I_{PH}}{I_0}$ $\quad I_{PH} = |I_{SC}|$ $\Rightarrow V_{OC} = V_{TH} \ln\left(\frac{I_{SC}}{I_0}\right) =$

$$= 25{,}8\,mV \cdot \ln\left(\frac{32{,}5\,mA}{60\,nA}\right) = 0{,}519\,V$$

ok hp verificata

b) DOBBIAMO PROCEDERE PER VIA ITERATIVA

$$\begin{cases} I = -I_{PH} + I_0\left(e^{\frac{V}{V_{TH}}} - 1\right) = I_{SC} + I_0\left(e^{\frac{V}{V_{TH}}} - 1\right) \\ I = -\frac{V}{R} \end{cases}$$

↳ trascuro il $-1$

$$I = -\frac{V}{R} = -\frac{V_{TH}}{R} \ln\left(\frac{I - I_{SC}}{I_0}\right)$$

con $I_{SC} = -32{,}5\,mA$

$I^0$ my guess $\rightarrow \frac{I_{SC}}{2} = -16{,}2\,mA$

$I^{(1)} = -25{,}05\,mA$

$I^{(2)} = -24{,}04\,mA$

$I^{(3)} = -24{,}2\,mA$

$I^{(4)} = -24{,}18\,mA \rightarrow V = -RI = 0{,}484\,V$

c) $\eta = \dfrac{|I'V'|}{I_{\text{ph}} \cdot A} = \dfrac{11{,}07\,\mathrm{mW}}{0{,}1\,\frac{\mathrm{W}}{\mathrm{cm}^2} \cdot 1\,\mathrm{cm}^2} = 11{,}07\,\%$