Soluzione esercizio Nd-YAG

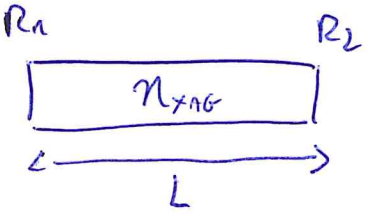
a) Calcolare l'energia $E_{PH}[eV]$ del singolo fotone emesso dal laser

$$E_{PH}[J] = \frac{hc}{\lambda_0}$$

$$E_{PH}[eV] = \frac{hc}{q\lambda_0} = \frac{1{,}24\ eV \cdot \mu m}{\lambda_0[\mu m]} = \frac{1{,}24\ eV \cdot \mu m}{1{,}064\ \mu m} = 1{,}165\ eV$$

b) Calcolare il numero di modi oscillanti in cavità

Possiamo rappresentare schematicamente la cavità:



Per avere interferenza costruttiva (risonanza):

$$m\frac{\lambda}{n} = 2L \rightarrow m = \frac{2nL}{c}\nu \rightarrow dm = \frac{2nL}{c}\cdot d\nu$$

$$\Delta\nu_{FSR} = \frac{c}{2nL} = 915\ MHz$$

$$M = \frac{\Delta\nu_{1/2}}{\Delta\nu_{FSR}} = 137{,}68 \rightarrow 137\ \text{Modi}$$

C) DETERMINARE LA RIFLETTIVITÀ R_2 DELLA FACCETTA DI USCITA

$$\tau_{AM} = \frac{n}{c\alpha_T} \Rightarrow \alpha_T = \frac{n}{c\tau_{AM}} \simeq 0,505\ m^{-1}$$

$$\alpha_T = \alpha_S + \frac{1}{2L} \ln\left(\frac{1}{R_1 R_2}\right) \Rightarrow R_2 = \frac{1}{R_1} e^{-2(\alpha_T - \alpha_S)L} = 94,58\%$$

SOLUZIONE ESERCIZIO LED

DATI

LED lambertiano

$I_F = 50\,mA$

$V_F = 1\,V$

$\eta_{EQE} = 0{,}15$

a)

$$E_{GAP}(T) = E_{GAP}(0K) - \frac{AT^2}{T+B} \Rightarrow E_{GAP}(300K) = 0{,}74\,eV$$

$$\lambda_0\,[\mu m] \sim \frac{1{,}24}{E_{GAP}[eV]} \simeq 1{,}68\,\mu m$$

$$\Delta\lambda_{1/2} = \frac{\lambda_0^2}{hc}\Delta E \sim \frac{\lambda_0^2}{hc} 3KT = 176\,nm$$

b)

$$\eta_{PCE} = \frac{P_{O\,LED}}{I_F V_F}$$

$$\eta_{EQE} = \frac{P_{O\,LED}}{I_F}\cdot\frac{q}{h\nu} = \eta_{PCE}\cdot\frac{V_F q}{h\nu} \rightarrow \eta_{PCE} = \frac{\eta_{EQE}\cdot h\nu}{q V_F} = 0{,}11$$

c)

$$P_{O\,LED} = \eta_{PCE}\cdot I_F \cdot V_F = 5{,}5\,mW$$

$$M \sim \frac{V^2}{2} = 8 \Rightarrow V = 4$$

$$V = \frac{\pi d}{\lambda_0} NA \rightarrow NA = \frac{\lambda_0 V}{\pi d} \simeq 0{,}11 \qquad P_{O\,FIBRA} = NA^2 \cdot P_{O\,LED} =$$

$$= 63\,mW$$

SOLUZIONE ESERCIZIO PIN

2)

$$A = \pi \left(\frac{d}{2}\right)^2 = 1{,}26 \cdot 10^{-3}\ cm^2$$

$$P_0 = I_{OTT} \cdot A = 0{,}1 \frac{mW}{cm^2} \cdot 1{,}26 \cdot 10^{-3}\ cm^2 = 126\ mW$$

1) $\lambda = \lambda_1 = 800\ nm \rightarrow \alpha = \alpha_1 = 0{,}1\ \mu m^{-1} \rightarrow L_{ASS,1} = \frac{1}{\alpha_1} = 10\ \mu m$

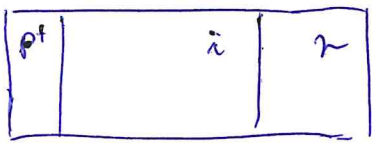
$$P_{ASS\,pt} = P_0 \left(1 - e^{-\alpha_1 W_{pt}}\right) \cong 12\ mW$$

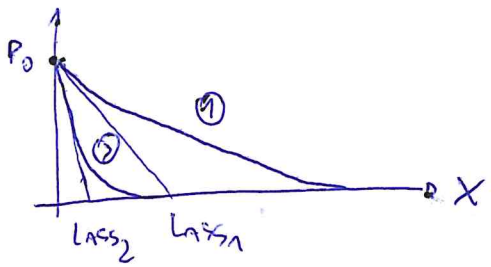
$$P_{ASS\,i} = P_0 \left(e^{-\alpha_1 W_{pt}} - e^{-\alpha_1 (W_{pt} + W_i)}\right) = 0{,}782 \cdot P_0 = 98{,}6\ mW$$

2) $\lambda = \lambda_2 = 550\ nm \Rightarrow \alpha = \alpha_2 = 1\ \mu m^{-1} \rightarrow L_{ASS,2} = \frac{1}{\alpha_2} = 1\ \mu m$

$$P_{ASS\,pt} = P_0 \left(1 - e^{-\alpha_2 W_{pt}}\right) = 79{,}65\ mW$$

$$P_{ASS\,i} = P_0 \left(e^{-\alpha_2 W_{pt}} - e^{-\alpha_2 (W_{pt} + W_i)}\right) \cong 46{,}3\ mW$$





b) $P_{ASS_2}^{(\lambda=\lambda_2)} = P_0 \left(e^{-\alpha_2 W_{pt}} - e^{-\alpha_2 (W_{pt} + W_2)} \right) \simeq P_{ASS_2}^{(\lambda=\lambda_1)} = 98{,}6\ mW$

APPROSSIMAZIONE:

$$e^{-\alpha_2 (W_{pt} + W_2)} \sim e^{-\alpha_2 W_2}$$

$$W_{pt} = -\frac{1}{\alpha_2} \ln \left(\frac{P_{ASS_2}^{(\lambda=\lambda_1)}}{P_0} \right) = 9{,}265\ mm$$

c) $$I_{PH} = \frac{q\eta}{h\nu} P_0 = \frac{q\eta}{hc} \lambda_1 P_0 \rightarrow \eta = 0{,}74$$

$$\eta \cong e^{-\alpha_1 W_{pt}} - e^{-\alpha_1 (W_2 + W_{pt})} \Rightarrow$$

$$\Rightarrow W_2 = -\frac{1}{\alpha_1} \ln \left(1 - \eta e^{\alpha W_{pt}} \right) \simeq 17\ mm$$