SK2411, IO2659 VT2009 Exam solutions

Task 1

(a)

$\frac{P_{out}}{P_p} = A_b I_s \frac{\gamma_2}{2} \frac{1}{P_{th}}$

$P_{th} = \frac{\gamma h\nu_p \pi(w_o^2 + w_l^2)}{2\eta_p \tau \sigma_e}$

$I_s = \frac{h\nu}{\sigma\tau}$, $A_b = \pi w_0^2$, $\gamma = \gamma_2/2$,

$\frac{P_{out}}{P_p} = \eta_p \frac{h\upsilon_e}{h\upsilon_p}$

(b)

$P_h = P_{out}(\frac{\lambda_e}{\lambda_p} - 1)$

Nd:YAG 31.7W

Yb:YAG 10.6 W

Task 2.

(a)..

(b)..

(c)

$\frac{P_{ih}}{P_h} = \frac{\sigma_h \tau_h}{\sigma_{ih}\tau_{ih}} = \frac{\Delta\upsilon_{ih}\tau_h}{\Delta\upsilon_h \tau_{ih}\sqrt{\pi ln2}} = 207.8$

Task 3.

(a) (i)

(b) Excimer

(c)

$h\upsilon_{J'+1} - h\upsilon_{J'} = 2B$

Task 4.

(a) …

(b) $\begin{bmatrix} 1 & 0 \\ \frac{n_1 - n_2}{n_1 R_1} + \frac{n_2 - n_1}{n_1 R_2} & 1 \end{bmatrix}$, so $f = \frac{n_2 - n_1}{n_1}\left(\frac{1}{R_2} - \frac{1}{R_1}\right)$

(c) At far field, $\theta_d = \lambda/\pi w_0$, so w_0=0.632x10^{-3} mm/(π x10^{-3} rad)=0.2 mm. P=(πw_0^2/2)I_0, so I_0=79.5 mW/mm^2.

Task 5.

(a) …

(b) Radiative efficiency, transfer efficiency, absorption efficiency, and quantum efficiency.

(c) The elemental power dP absorbed within volume dV can be written as *dP=[$I_p(r,z)$- $I_p(r,z+dz)$]dS=-dI_p/dz * dzdS=)=$\alpha I_p(r,z)$dV.* By definition, we then have *dP=$R_p h\nu_p$dV,* so *$R_p(r,z)$==$\alpha I_p(r,z)/h\nu_p$*.

Task 6.

(a) …

(b) $R_{cp}=(fNt+Nc)/(1+f)\tau$

(c) $\gamma = \gamma_t + (\gamma_1 + \gamma_2)/2 = 0.03 + (-lnR1 - lnR2)/2 = 0.05$. $Nc = \gamma/\sigma_e l = 3.08 \times 10^{17}\ cm^{-3}$.

(d) $\Delta\tau_p = \frac{0.441}{\Delta v_L} = \frac{0.441}{11*3E10} = 1.33\ ps.$