(2) Sheet 8

a) $$J_{sat} = \frac{hc}{\lambda(\sigma_a + \sigma_e)}$$

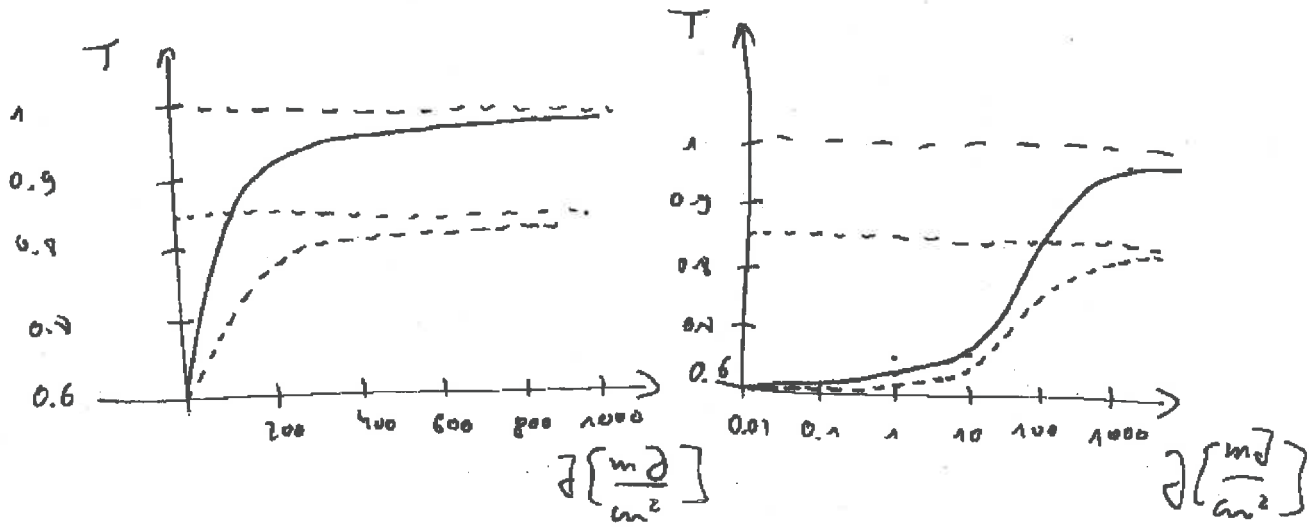
$\sigma_e = 0$

$$\Rightarrow J_{sat} = \frac{hc}{1.064\,\mu m\,(7\cdot 10^{-19}\,cm^2)} = 26.7\,\frac{mJ}{cm^2}$$

b) $$T_0 = e^{-\sigma_a^* N^* L^*}$$

$$\Rightarrow N^* = -\frac{1}{L^*\sigma_a^*}\ln T_0 = 2.92\cdot 10^{23}\,m^{-3}$$

c)



$$T_{max} = e^{-\sigma_a^* \cdot 100 \cdot N^* \cdot L^*} = 0.864$$

/1

P23

a) $\omega_0 = \frac{2\pi c}{\lambda} = 2.35 \cdot 10^{15}\ s^{-1}$

$b = 0.01\ \frac{\omega_0}{\tau_p} = 1.57 \cdot 10^{-3}\ fs^{-2}$ $\qquad a = \frac{2\ln 2}{\tau_p^2} = 6.16 \cdot 10^{-3}\ fs^{-2}$

$\Rightarrow \xi = a - ib = \underline{\left(6.16 \cdot 10^{-3} - i \cdot 1.57 \cdot 10^{-3}\right) fs^{-2}}$

b) $\Delta\nu_p = \frac{\sqrt{2\ln 2}}{\pi} \cdot \sqrt{a\left(1 + \left(\frac{b}{a}\right)^2\right)}$

$= \underline{3{,}04 \times 10^{13}\ Hz}$

$\frac{\Delta\lambda}{\lambda} = \frac{\Delta\nu}{\nu} \Rightarrow \Delta\lambda_p = \lambda\ \frac{\Delta\nu_p}{\nu} = \underline{64{,}9\ nm}$

$\Delta\nu_p \cdot \tau_p = \underline{0.456}$

c) $\tau_{p,min} = \frac{\tau_p(0)}{\sqrt{1 + \left(\frac{b_0}{a_0}\right)^2}} = \underline{14{,}5\ fs}$

/2

P24

a) $\Delta n = n_2 I \qquad \frac{\Delta n}{n_0} \ll 1 \qquad \Theta_c \ll 1$

$$\Rightarrow \quad \cos\Theta_c = \frac{1}{1+\frac{\Delta n}{n_0}} \quad \Rightarrow \quad \cancel{1} - \frac{1}{2}\Theta_c^2 \approx \cancel{1} - \frac{\Delta n}{n_0}$$

$$\Rightarrow \quad \underline{\Theta_c^2 \approx \frac{2\Delta n}{n_0}}$$

Self focusing occurs for $\Theta_c > \Theta_0$ (or $\Theta_c^2 > \Theta_0^2$)

$$\Rightarrow \quad \frac{2\Delta n}{n_0} > \frac{(1.22)^2 \cdot \lambda^2}{n_0^2 D^2}$$

$$\Rightarrow \quad 2\frac{n_2}{n_0} I > \frac{(1.22)^2 \lambda^2}{n_0^2 D^2} \qquad \Big| \cdot \frac{\pi D^2}{4} \cdot \frac{n_0}{2n_2}$$

$$\Rightarrow \quad \underbrace{\frac{\pi D^2}{4} I}_{P_{cr}} > \frac{\pi (1.22)^2 \lambda^2}{8 n_0 n_2}$$

$$\Rightarrow \quad P_{cr} \approx 1.49\pi \frac{\lambda^2}{8 n_0 n_2}$$

b)
$$P_{cr} = 1.49\pi \cdot \frac{(800\,nm)^2}{8 \cdot 1.48 \cdot \left(2.1 \cdot 10^{-16} \frac{cm^2}{W}\right)} = \underline{\underline{12\,MW}}$$