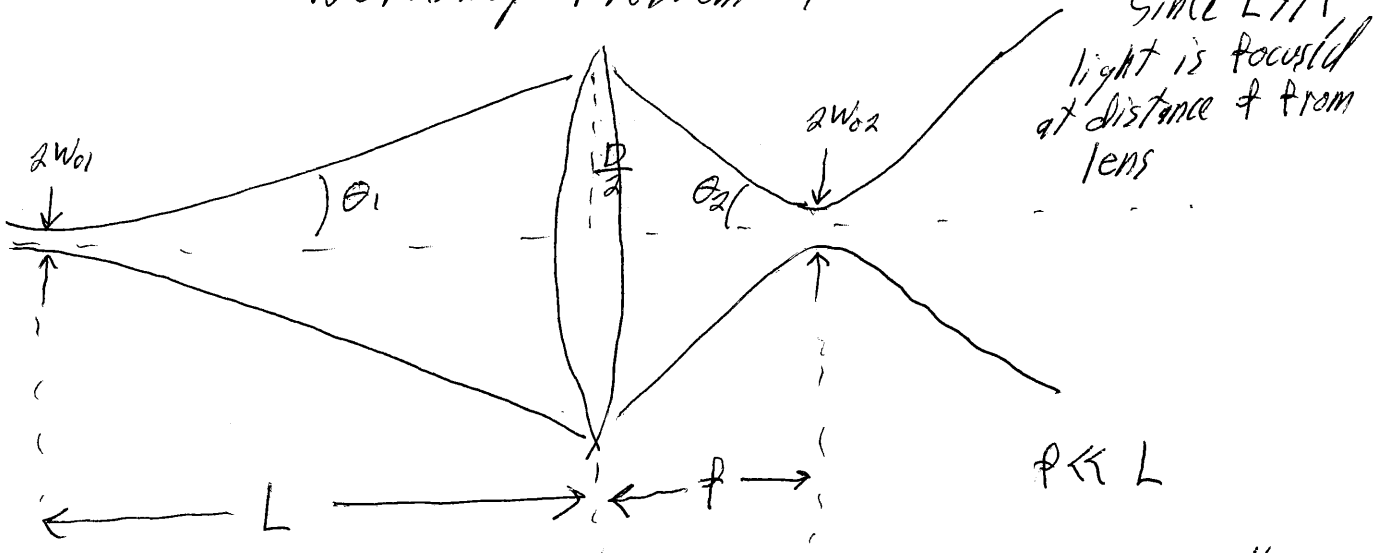
PH2502 Lasers

Workshop Problem 1



a) $\theta_1 \simeq \frac{\lambda}{\pi w_{01}}$, $w_{01} = \frac{\lambda}{\pi\theta_1} = \frac{1.064\cdot10^{-6}\,m}{\pi(2.5\cdot10^{-3})} = 1.35\cdot10^{-4}\,m$
$= \boxed{0.135\,mm}$

b) $\theta_1 \simeq \frac{D/2}{L}$, $L \simeq \frac{D}{2\theta_1} = \frac{1.25\cdot10^{-2}\,m}{2(2.5\cdot10^{-3})} = \boxed{2.5\,m}$ $L>>f$

c) $B = \frac{P}{A_s\Omega} = \frac{15\,W}{\pi(1.35\cdot10^{-4}m)^2\pi(2.5\cdot10^{-3})^2} = \boxed{1.334\cdot10^{13}\,\frac{W}{m^2\cdot sr}}$

d) $\theta_2 \cong \frac{D/2}{f} = \frac{\lambda}{\pi w_{02}}$, $w_{02} = \frac{2\lambda f}{\pi D} = \frac{2(1.064\cdot10^{-6}m)(0.025m)}{\pi(0.0125\,m)}$
$\theta_2 \approx \frac{.625}{2.5} = 0.25$ $w_{02} = 1.35\cdot10^{-6}\,m \approx \boxed{1.35\,\mu m}$

e) $I_{peak} = \frac{2P}{\pi w_{02}^2} = \frac{2(15\,W)}{\pi(1.35\cdot10^{-6})^2} = \boxed{5.24\cdot10^{12}\,W/m^2}$

f) $B = \frac{15\,W}{\pi(1.35\cdot10^{-6}m)^2\pi(0.25)^2} = \boxed{1.334\cdot10^{13}\,\frac{W}{m^2\cdot sr}}$

g) Beam radius can increase by at most $\sqrt{2}$ (area doubles).
$w_2 = w_{02}\sqrt{2}$ at $z = z_0$ so tolerance is $z = f \pm z_0$
$z_0 = \frac{\pi w_{02}^2}{\lambda} = \frac{\pi(1.35\cdot10^{-6}m)^2}{1.064\cdot10^{-6}\,m} = \boxed{5.4\cdot10^{-6}\,m}$