哈尔滨工业大学

一九九0年研究生考试试题标准答案　　

考试科目：激光原理　　报考专业：电子物理与器件 光学(激光技术)

一. 周炳琨《激光原理》P2-P3.

二. 周炳琨《激光原理》P170-P173.

三. 周炳琨《激光原理》P185-P186.

四.

1). $\eta = \frac{A_{21}}{A_{20}+A_{21}} = \frac{1/\tau_{21}}{1/\tau_{20}+1/\tau_{21}} = \frac{10^6}{10^5+10^6} = 0.99.$

2). $\Delta\nu_D = 7.16\times10^{-7}\left(\frac{T}{M}\right)^{1/2}\nu_{21}$

$= 7.16\times10^{-7}\left(\frac{273+125}{133}\right)^{1/2}\cdot\frac{(4.2-1.8)\times1.6\times10^{-19}}{6.626\times10^{-34}}$

$= 7.16\times10^{-7}\times1.73\times5.8\times10^{14}$

$= 7.18\times10^{8}\ (Hz)$

3). $\Delta\nu_N = \frac{1}{2\pi\tau} = \frac{1}{2\pi}\left(\frac{1}{\tau_{20}}+\frac{1}{\tau_{21}}+\frac{1}{\tau_{10}}\right) = \frac{1}{2\pi}\left(10^5+10^6+10^8\right)$

$\simeq 1.6\times10^{7}\ (Hz)$

4). $\sigma_{21} = \frac{V^2}{4\pi^2\nu_{21}^2\tau_{21}\Delta\nu_L} = \frac{(3\times10^8)^2}{4\pi^2\times(5.8\times10^{14})^2\times10^{-6}\times8\times10^9}$

$= 8.47\times10^{-19}\ m^2.$

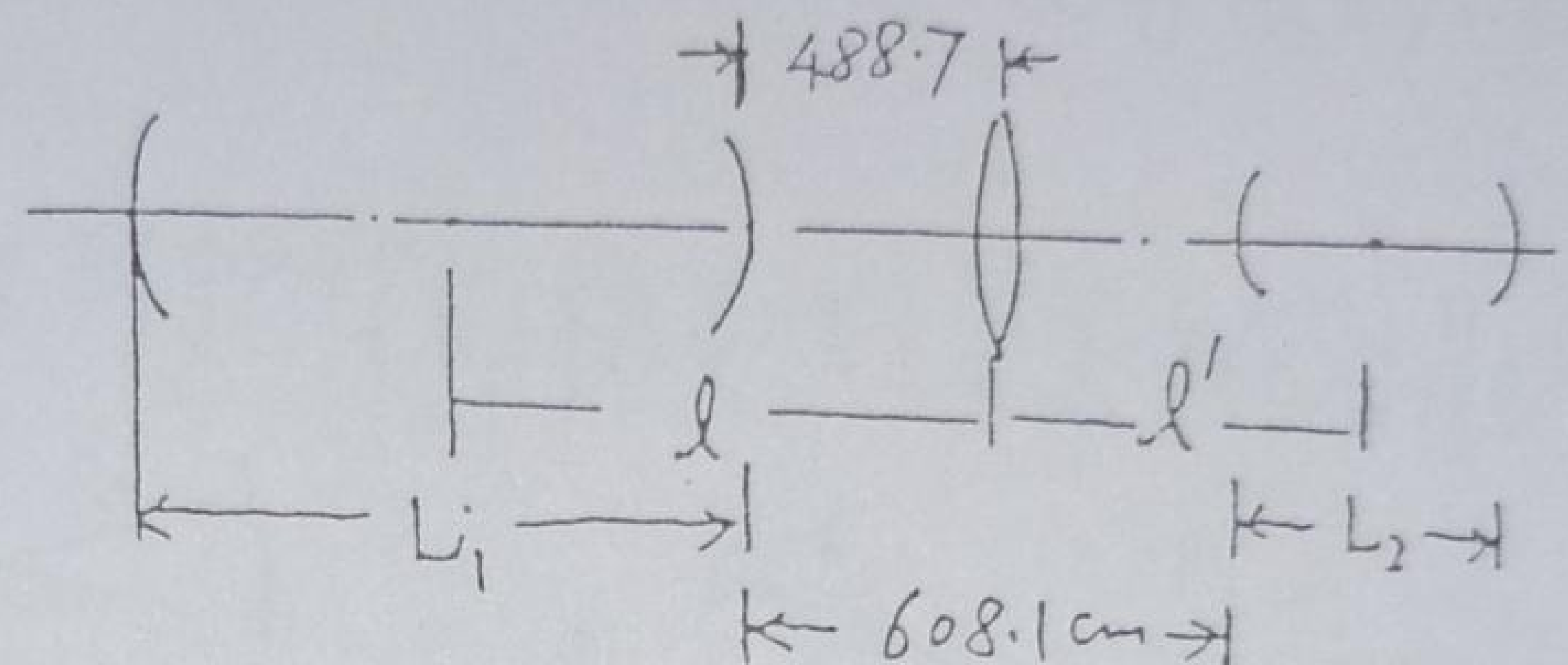
5). 单程平均损耗

$$\delta \simeq \frac{(1-r_1)+(1-r_2)}{2} + 2\times 0.5\% = 0.04$$

阈值增益系数

$$G_t = \frac{\delta}{l} = \frac{0.04}{0.50} = 0.08/m.$$

五.



解：由等价共焦腔腔长：

对激光器：$l_1 = (2R_1L_1 - L_1^2)^{\frac{1}{2}} = 173.2\,cm.$

对干涉仪：$l_2 = (2R_2L_2 - L_2^2)^{\frac{1}{2}} = 8.66\,cm.$

束腰半径：$w_0 = \left(\frac{\lambda l_1}{2\pi}\right)^{1/2}$，$w_0' = \left(\frac{\lambda l_2}{2\pi}\right)^{1/2}$.

$$f_0 = \frac{\pi w_0 w_0'}{\lambda} = \sqrt{l_1 l_2}/2 = 19.36\ (cm).$$

$$l = F \pm \frac{w_0}{w_0'}\sqrt{F^2 - f_0^2} = 100 \pm \sqrt{\frac{l_1}{l_2}}\,(100^2 - 19.36^2)^{\frac{1}{2}}$$

$$= 100 \pm \sqrt{20}\times 98.1 = 100 + 438.7 = 538.7\ (cm).$$

$$l' = F \pm \frac{w_0'}{w_0}\sqrt{F^2 - f_0^2} = 100 \pm 0.224\times 98.1 = 121.9\ (cm).$$

六、兰信钜《激光技术》. p44－p46

七、兰信钜《激光技术》. p164－p166, p180－p189.