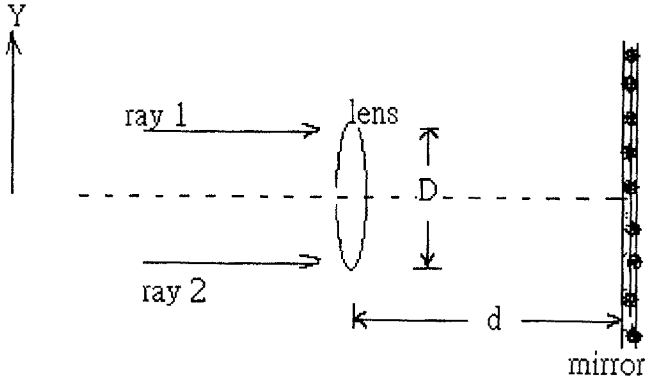
國立清華大學命題紙

九十五學年度第一學期光電工程研究所博士班研究生資格考試

科目：光電子學　共三頁 第一頁　＊請在試卷（答案卷）內作答

1. Find the ray –transfer matrix for an optical system which contains a thin lens and a mirror, as shown below. (5%) Note that the ray-transfer matrices for a lens, a section of free space and a mirror are, respectively,

$$\begin{pmatrix} 1 & 0 \\ -1/f & 1 \end{pmatrix}, \begin{pmatrix} 1 & d \\ 0 & 1 \end{pmatrix}, \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}.$$



(b) Find d such that a collimated beam (which contains infinitely many rays, such as rays 1 and 2) incident upon the lens can emerge as a collimated beam. Hint: Use the transfer matrix to calculate an output beam with an angle of 0° . In that case you will see that ray 1 enters at Y=D/2 and emerges at Y= –D/2. Show that. (7%)

2. Derive an expression for the intensity I of the superposition of two monochromatic plane waves of wavelength λ traveling in opposite directions along the z axis. Sketch I versus z. (8%)

3. A fundamental Gaussian laser beam of power P = 1W at a wavelength of λ = 532 nm is focused to a small spot radius of w_0 = 10 μm at its beam waist. Please answer the following question:

(a) What is the peak intensity I_0 at the beam waist? (2%)

(b) What is the divergence angle of the beam? (3%)

(c) What are its spot size and peak intensity at a distance of 1 m form the beam waist? (5%)

(d) If the spot size is reduced by half to $w_0 = 5\ \mu m$ at the beam waist, what are the changes of the peak intensity at the beam waist and at 1 m from the waist? (5%)

4. (5%) (a) How to define the ***temporal coherence function*** and how to measure it from experiments?
(b) What is the meaning of the ***coherence time*** and how to define it from your temporal coherence function?

5. (10%) A dielectric with one single resonance may be modeled as a distribution of "+" and "-" charges, the + charges immobile and the - charges tied to the + charges,

$$\left(\frac{d^2}{dt^2} + 2\beta\frac{d}{dt} + \omega_0^2\right)\vec{x} = -\frac{e}{m}\vec{E},$$

where e is the electron charge; m is the mass of the bound charge; ω_0 is the resonance frequency, β is the damping coefficient and $\vec{x}$ is the displacement of – charges from + charges. The polarization density is $\vec{P} = -Ne\vec{x}$, and N is the number of charges per unit volume. Show that one has a ***Lorentzian*** linespace in atomic absorption spectrum by $\vec{P} = \varepsilon_0 \chi_e \vec{E}$.

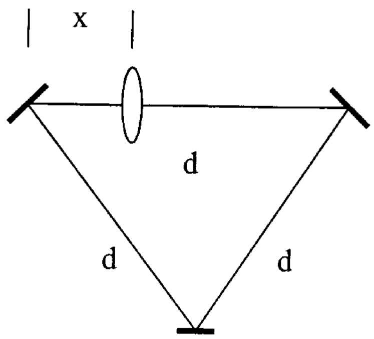
6. (5%) Write down the mathematical "*form*" for a ***chirped*** Gaussian pulse and explain what is the effect of such a chirp parameter.

7. Show graphically, how to determine the directions of light transmit through interface between an optical isotropic medium and an optical uniaxial medium. (7%)

8. Show that a linear polarized light can be decomposed into a right and a left circular polarization. (5%)

9. Design a simple optical set-up that can transmit light that propagate in one direction and block light in the opposite direction. Analyze your set-up. (8%)

10. A triangular ring resonator of cavity length L = 3d for operating at wavelength λ is installed with a thin lens of focal length f as shown.



(1) Find the condition for a Gaussian mode to exist. (6%)

(2) Find the size and position of the beam waist w_o for the Gaussian beam in the cavity. (8%)

(3) Find the beam spot size w at the lens. (3%)

11. The spectral line shape of an atomic transition from a physical system, such as a star, was recorded to be S(ν). We want to determine the temperature and gas pressure in the physical system by analyzing S(ν). Propose and explain your method. (8%)