國立清華大學命題紙

一百零二 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 光電子學一 科號_____ 共 2 頁第 ___ 頁 *請在試卷(答案卷)內作答

1. (10%)

(a) (3%) Assume you have a thin lens (with focal length f) used to image an object (object with height h, placed $3f$ in front of the lens). Plot the three main rays that are typically used to locate the image location.

(b) (2%) Write down the ABCD matrix for a thin lens.

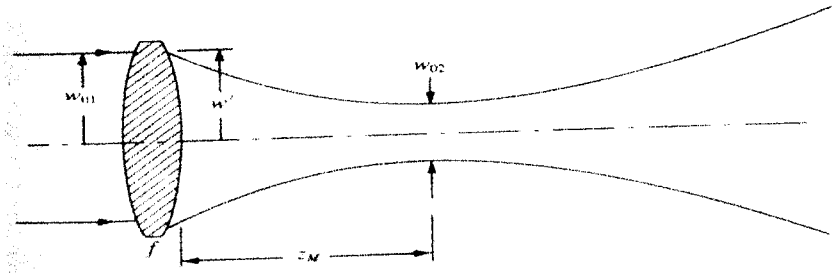
(c) (5%) Use your results in (a) and (b), verify the three main ray directions and positions after the lens.

2. (15%)

Give an example for the application of the Michelson interferometer. Describe in detail the basic principle, requirements, and analysis.

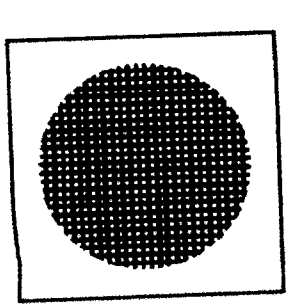
3. (10%)

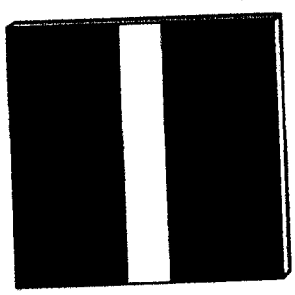
As shown in the figure, a thin lens with focal length f is used to focus a large-diameter Gaussian beam with a planar wave front with w_{01} and λ_0. What will be the minimum focal spot size w_{02} and where will it occur z_M?

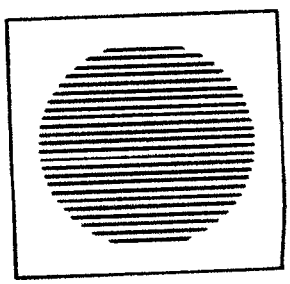


4. (15%)

For the figure shown below, the left-hand side is a transparency as the object, the right-hand side is its image after spatial filtering by a mask as shown in the center (the white part represents complete transparent and the dark part represents complete opaque). Show and explain the basic principle in detail in terms of the language of Fourier optics as how to arrange the filter and the imaging system to obtain the result ?







5. (15%)

Consider Maxwell's equations in phasor representation:

$$\nabla \cdot \mathbf{D} = 0$$
$$\nabla \times \mathbf{E} = -j\omega\mathbf{B}$$
$$\nabla \cdot \mathbf{B} = 0$$
$$\nabla \times \mathbf{H} = j\omega\mathbf{D}$$

(a) Write down the expression of Poynting vector. (8%)

(b) Derive the expression of time-average Poynting vector. (7%)

6. (10%)

Consider a circularly polarized He-Ne laser beams (wavelength is 633 nm) propagating along the *z*-axis. Describe the output states of polarization if the laser beam passes through the following media: (a) Nitrogen (N_2) gas, (b) glass, (c) quartz. Justify your answers.

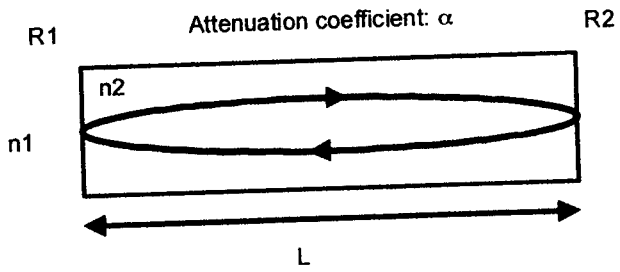
7. (15%)

Consider electromagnetic waves resonating inside a Fabry-Perot cavity as shown in the figure below. R1 and R2 are the reflectivity at the two end of the cavity. a is the attenuation coefficient and n1, n2 are the refractive indices.

(1) (5%) What is the free spectrum range, if we don't consider the waveguide dispersion?

(2) If light pass through this Fabry-Perot cavity (for example, from left to right), please sketch the transmittance spectrum.

(3) Continue in (2), what is the dynamic range of transmittance (T_{max}/T_{min}) ?



8. (10%)

Plot the photon number distribution, $P(n) = |\langle n|\varphi\rangle|^2$, as a function of photon numbers for the state, $|\varphi\rangle$

(a) Number state, $|\varphi\rangle = |n = 3\rangle$;

(b) Coherent state, $|\varphi\rangle = |\alpha = 3\rangle$;