國立清華大學命題紙

九十 學年度第一學期 電機工程 學系 博士班研究生資格考試

科目 光電子學 科號 共 2 頁第 1 頁 *請在試卷(答案卷)內作答

1. A periodic lens system consisting of many identical thin convex lenses of focal length 50 cm is used to guide an initially-collimated optical beam of wavelength λ.

(a) Write the ray matrix (i.e., the ABCD matrix) of a thin lens. (5%)

(b) What would be the required lens separation for perfect light guiding ? (8%)

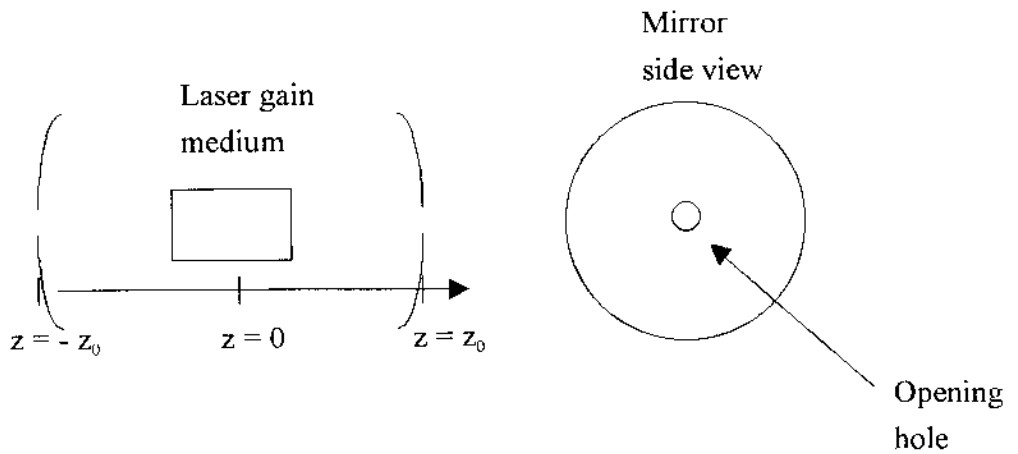
2. A spherical wave of wavelength λ is incident upon an ideal thin lens (with the focal length f) and then focused.

(a) Write an expression to represent the input spherical wave. (4%)

(b) Write the expression for the output wave, i.e., the wave right after the lens. (8%)

3. From classic optics, you learned that all waves are diffractive. For example, a focused Gaussian laser beam or a plane wave going through an aperture diverges due to diffraction. Explain why a Bessel beam, which is an exact solution of the Helmholtz equation, is non-diffractive. Give physical reasons. No explanation, no credit. (4%)

4. (Explain all your answers in physics. No physics/explanation, no credit. 15%)



A symmetric laser resonator consists of two identical mirrors with a hole at the center of each mirror. The two mirrors are at $z = \pm z_0$. The laser resonator has a gain medium in the middle of the cavity.

a. Let the hole have a dimension smaller than the laser wavelength,

a.1) how would you expect the laser transverse modes in this cavity comparing to those in one without the holes? (3%)

a.2) conceptually plot the transverse laser intensity profiles at $z = 0$, and $\pm z_0$; (3%)

a.3) conceptually plot the longitudinal laser intensity along z. (3%)

b. If the hole has a dimension much larger than the laser wavelength but much smaller than the mirror size,

b.1) conceptually plot the transverse laser intensity profiles at $z = 0$, and $\pm z_0$; (3%)

b.2) conceptually plot the longitudinal laser intensity along z.(3%)

5. A plane wave is an exact solution of the wave equation, and you have used plane waves in analysis for many real world problems.

(a) Argue that a perfect plane wave does not exist in the real world. (3%)

(b) If you agree with "a", based upon what reason would it allow you to use a non-existing entity to model a real world problem? (3%)

6. If you want to avoid double refraction when you are dealing with an uniaxial crystal, how would you cut the crystal, i.e. orientation of the optical axis with respect to the cutting surface, and arrange the angle of incidence? Explain your answer in details. The incident light is assumed to be randomly polarized. (15%)

7. How do you turn a circularly polarized light into a linearly polarized light. Explain. (5%)

8. What is the working principle of the commercial 3-D movie? Explain. (5%)

9. A symmetrical confocal resonator with cavity length of d=150 mm is formed using two mirrors of reflectance $R_1=R_2=96\%$.

(1) Find the radius of curvature of the mirrors.

(2) Find the longitudinal mode spacing.

(3) Find the frequency difference between adjacent Hermite-Gaussian modes.

(4) Find the FWHM linewidth $\Delta\nu$.

(16%)

10. The absorption spectrum of an atomic sample is found to have a Doppler broadened lineshape at a transition wavelength $\lambda_1=1.2$ μm. The linewidth is $\Delta\nu_1=5$ MHz at a temperature of T=27 °C.

(1) If there is a transition at wavelength $\lambda_2=0.4$ μm, find its linewidth $\Delta\nu_2$. (4%)

(2) Find the linewidth $\Delta\nu_1$ and $\Delta\nu_2$ when the sample is heated to a temperature of 2427 °C. (5%)