

國立清華大學命題紙

九十二學年度第二學期

光電工程研究所

博士班研究生資格考試

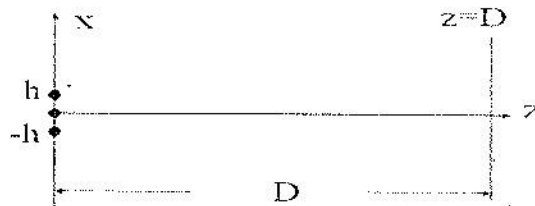
科目 光電子學 科號

共 3 頁第 1 頁

*請在試卷(答案卷)內作答

1. (a) (3%) Determine the focal length f of a biconvex lens with radii 20 cm and 50 cm and refractive index $n=1.5$. (b) (3%) What is the focal length when the lens is immersed in water ($n=4/3$)? (c) (4%) How deep will parallel rays be focused in the water if only the side of radius 50 cm is immersed in water?

2. Three mutually coherent point sources of equal I_0 , originated at the points $(h,0,0)$, $(0,0,0)$ and $(-h,0,0)$ with initial phase ϕ_1 , ϕ_2 , and ϕ_3 , respectively, interfere in the plane $z=D$ as shown in the figure below. (a) (10%) Find the intensity distribution on the plane $z=D$ under the paraxial approximation, assuming that $h \ll (\lambda D)^{1/2}$. Give a physical explanation if (b) (5%) $\phi_1=\phi_2=\phi_3=0$ or (c) (5%) $\phi_1=\phi_3=\pi/2$, and $\phi_2=0$.

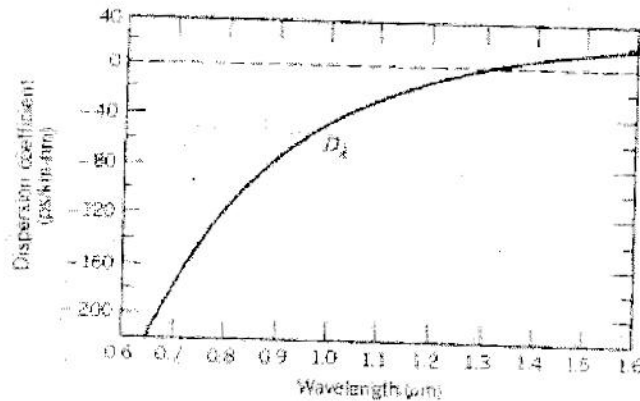


3. (10%) The light from a doubled Nd:YAG laser at wavelength 532 nm is a Gaussian beam of 1-W optical power with full beam divergence 2 mrad. Determine the beam waist radius, the depth of focus, the maximum intensity, and the on-axis intensity at a distance $z=1$ m from the beam waist.

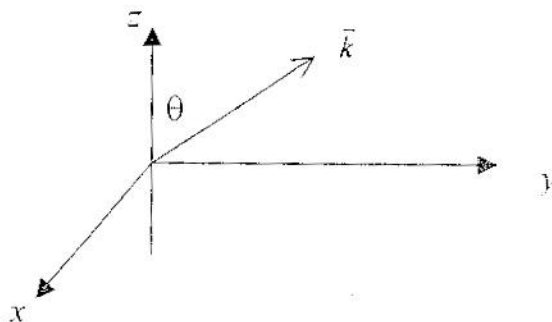
國立清華大學命題紙

九十二學年度第二學期 光電工程研究所 博士班研究生資格考試
 科目 光電子學 科號 共 3 頁第 2 頁 *請在試卷(答案卷)內作答

4. (3%) Prove that the imaginary part of the electric susceptibility χ gives electromagnetic-wave attenuation in a material.
5. (5%) The following plot is the dispersion coefficient versus wavelength of a silica material. An unchirped laser pulse of 1 ps pulse width and 1.6 μm wavelength is launched into a silica fiber of 1 km. The laser signal has a 100 GHz spectral width. What is the laser pulse width at the output end of this fiber?



6. The optic axis of a uniaxial material is aligned in the z direction. Assume that the \vec{k} vector of the two normal modes of electromagnetic waves in this material lies in the x - z plane, as shown below. When \vec{k} coincides with the y axis, an x -polarized wave sees a refractive index of n_o and a z -polarized wave sees a refractive index of n_e . When \vec{k} coincides with the z axis, a wave polarized in the x - y plane sees a refractive index of n_o .
 - a. (6%) Define the principal plane and give the polarization directions of the ordinary and extraordinary waves.
 - b. (6%) What are the refractive indices seen by the ordinary and extraordinary waves in this material for a \vec{k} vector pointing at an angle θ with respect to the optic axis?



國立清華大學 碩 試 紙

九十二學年度第二學期 光電工程研究所 博士班研究生資格考試

科目 光電子學 科號 共 3 頁第 3 頁 *請在試卷(答案卷)內作答

7. A one dimensional optical resonator formed by two plane mirrors with cavity length $d = 10$ cm.

(1) (5%) Find the density of mode $M(\nu)$, that is, number of modes per unit Hz per unit length.

(2) (5%) Find the total number of modes in the wavelength range of $1 \mu\text{m} \sim 1.01 \mu\text{m}$.

8. A laser beam with collimated beam size of 1 mm propagates through a Fabry-Perot filter. The cavity length of the Fabry-Perot is 0.1 mm and the finesse is $F = 100$.

(1) (5%) What is the mode spacing $\Delta\nu$ when the incident angle is $\theta = 30^\circ$?

(2) (5%) What is the FWHM band width at $\theta = 0^\circ$?

(3) (5%) Does the FWHM band width become larger or smaller when θ is increased? Explain your reason.

9. A gas system at temperature of 300°K is composed of atoms of single isotope. It is measured to have two absorption peaks centered at $\lambda_1 = 1 \mu\text{m}$ and $\lambda_2 = 5 \mu\text{m}$ with FWHM line width of $\Delta\nu_1$ and $\Delta\nu_2$, respectively.

(1) (5%) Find the ratio $\Delta\nu_1/\Delta\nu_2$ at very low pressure.

(2) (5%) Find $\Delta\nu_1/\Delta\nu_2$ at very high pressure.

(3) (5%) What would be the line shape $g(\nu)$ at high pressure? Explain.