國立清華大學命題紙

九十一 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 single frequency plane wave of wavelength λ = 1.0 μm passes a high speed optical chopper. The opening period of the chopper is τ_c = 10 ns. What is the linewidth of the output wave when it is measured by a spectrum analyzer? (6 %)

2. A laser beam of intensity I_o propagates through a gas medium of length L = 30 cm. If the absorption coefficient of the medium is α = 1 x 10^{-3} cm^{-1}, find the percentage of transmittance I/I_o. (8 %)

3. A pure CO_2 gas sample of pressure p = 100 Torr is found to have a pressure broadened linewidth of $\Delta\nu$ = 400 MHz and an absorption coefficient of α = 1 x 10^{-4} cm^{-1}. Find $\Delta\nu$ and α when the pressure is increased to p = 500 Torr. (10 %)

4. Use the principle of geometric optics to derive the Snell's laws of reflection and refraction. (10%)

5. Two beams originating from the same source are incident on a screen. Can you see a fringe pattern owing to interference if the two beams come to the screen with a path length difference that is larger than the source's coherence length? Explain your answer using the interference equation $I = I_1 + I_2 + 2(I_1 I_2)^{1/2} \cos\Phi$, where I represents intensity and Φ the phase difference.(10 %)

6. Consider the phasor fields of two plane waves in space given by
$U_1 = \sqrt{I_0}e^{j\phi_1}$ and $U_2 = \sqrt{I_0}e^{j\phi_2}$.
   a. What is the total intensity resulting from the interference of these two waves? (4%)
   b. If you work out the right answer, the maximum intensity derived in "a" is $4I_0$, which is twice the intensity summed from individual waves without interference. Does this answer violate energy conservation? Explain and defend your answer. (4%)

7. Consider N electric dipoles localized at one point in space with their complex fields given by
$U_1 = \sqrt{I_0}e^{j\omega_1 t}$, $U_2 = \sqrt{I_0}e^{j\omega_2 t}$, ..., $U_N = \sqrt{I_0}e^{j\omega_N t}$.
   a. If $\omega_1 = \omega_2 = ... = \omega_N$, what is the intensity measured in the far field? (4%)
   b. If $\omega_1, \omega_2, ..., \omega_N$ are random numbers, what is the intensity measured in the far field? (4%)

   Explain and defend your answers from physics point of view.

國立清華大學命題紙

九十一 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 2 頁 *請在試卷(答案卷)內作答

8. A Fabry-Perot interferometer consists of two high-reflecting surfaces. Explain why the transmission of the Fabry-Perot interferometer can be 100% at the resonance frequencies even though each of the reflecting surfaces could have a reflectance, say, larger than 99.5% at those frequencies.(5%)

9. From physics point of view, what is the origin of the Guoy phase shift in a Gaussian laser beam?(5%)

10. Given an optical uniaxial crystal, how would you cut the crystal, i.e. what would be the orientation of the optical axis with respect to the cutting surface, such that for a light beam normal incident on the cutting surface there is no beam splitting. Explain in detail. (5%)

11. Given a linear polarizer, without using another polarizer nor other optical devices, how do you determine the orientation of the transmission axis? Explain. (5%)

12. Usually, we can observe double images through a piece of optical uniaxial crystal, how do you block one of the image? Explain. (5%)

13. What do we mean by saying that an optical media is linear, non-dispersive, homogeneous and isotropic. (10%)

14. What is the effect of material dispersion on optical pulse propagation? (5%)