Physics 123 section 2 CID ____________

Homework 30

Score ________ / 30

1. (5 pts) Two point sources of light are oscillating at exactly the same frequency, producing light with a wavelength of λ. I look at a point which is a distance s_1 from one source and a distance s_2 from the other. (a) If the two sources are oscillating exactly in phase, what must $s_1 - s_2$ be equal to for the two waves to interfere constructively and form an interference maximum? (b) What must $s_1 - s_2$ be equal to for the two waves to interfere destructively to form an interference minimum? (c) If the two sources are oscillating 180° out of phase, what must $s_1 - s_2$ be for the two waves interfere constructively to form an interference maximum?

2. (7 pts) The beam of a helium-neon laser ($\lambda = 632.8\text{nm}$) is incident on two vertical slits which are spaced by 0.1 mm. (a) If I place a screen 1 meter away from the slits, how far apart will the central bright interference fringes be spaced from each other? (b) If the intensity at the peak of the central interference maximum is $1.22 \times 10^{-8}\text{W/m}^2$, what will the intensity be at a point which is 2.5 mm to the right of the central interference maximum?

3. (4 pts) Monochromatic light of an unknown wavelength strikes a pair of slits which are separated by 0.002 mm. The interference maximums are at the following angles: 0°, ±14.9°, ±30.9°. What is the wavelength of the light?

4. (6 pts) Two coherent sources of light are both shining down onto a piece of paper. If I block source "A," the electric field at a given point on the paper is given by the equation $E_B = 1.4E_0 \sin(\omega t + 1.12\text{rad})$, where $E_0$is a constant. If I block source "B," the electric field at the same point on the paper is given by the equation $E_A = 2.3E_0 \sin(\omega t - 0.25\text{rad})$. When both sources are unblocked, the electric field is given by $E_{both} = AE_0 \sin(\omega t + \phi)$. Use phasor addition (i.e. complex exponentials) to find A and ϕ.

5. (8 pts) Monochromatic light with a wavelength λ passes through three parallel slits spaced from each other by a distance d. (a) Use phasor addition to show that the intensity in the interference pattern at an angle θ is given by:

$$I(\theta) = I_0 \left[1 + 2\cos\left(\frac{2\pi d \sin(\theta)}{\lambda}\right)\right]^2.$$

where I_0 is a constant. Assume that at any point in the pattern the amplitude of the oscillating electric field from each slit is the same, and only the phase will be different. (b) This pattern has two different types of "bright" fringes. The higher intensity maximums are known as "primary" maximums, and the lower intensity ones are known as "secondary" maximums. What is the ratio of the intensity in a primary maximum to the intensity in a secondary maximum? Assume that $\lambda < d$.

Extra problems I recommend you work (not to be turned in)

- Why don't two light bulbs make interference fringes? Hint: there is more than one reason...
- What would change if I did a double-slit experiment under water?
- I illuminate a screen with light from a single slit, and I see light all over the screen. I add a second slit, and now I see dark stripes with little or no light. Why doesn't this violate energy conservation? What happened to the energy that used to be present where we now have darkness?
- Two tall buildings stand close to one another. I am standing 200 meters from the gap between the buildings, equidistant from each building. A speaker on the other side of the gap is emitting a loud sine wave with a frequency of 8,000 Hz. It is annoying me, so I walk to the side. How far do I have to walk before I will be in an interference minimum?