Homework 5

Due March 10th, 2017 at 5pm

Reading Hecht Ch. 9 & Ch. 8.1-8.

1. A theory problem from the lab: Let r be the radius of a spherical ball bearing that is uniformly illuminated by coherent light. Is there constructive interference in the region behind this ball? Consider how this light hits a screen that is a distance z away from the ball along the optical axis. Find the separation x between neighboring interference maxima on this screen in terms of λ, z and r.

2. A second theory problem to support the lab: Using a technique that I hope to cover with you later in the semester, you can predict the intensity in the shadow behind the ball bearing. The prediction is
$$I(z, y) = \frac{I_0 z^2}{z^2 + r^2} J_0^2 \left(\frac{2\pi r y}{\lambda z} \right), \tag{1}$$
where I_0 is the initial intensity of the incident beam, z is again the distance from the ball bearing to the screen along the optical axis, r is the radius of the ball bearing, J_0 is the 0th order Bessel function, λ is the wavelength of the light, and y is the perpendicular distance from the optical axis to the point where you are measuring the intensity on the screen. Mathematica (or Wolfram Alpha) has the Bessel functions programmed in as *BesselJ[0,x]*, where the first argument is the order and the second is the variable. Use this feature to calculate the predicted ratios of the 3rd, 4th, 5th, 6th and 7th fringes to the 2nd for your experimental parameters. Becareful to note that while x is the fringe separation, y is measured from the center of the pattern.

3. Hecht 9.6. I'm assigning this problem because one of our senior projects, Eleanor Turrell's, has almost completed a radio interferometer and I thought you might enjoy thinking through this a little.

4. (**a**) Hecht 9.14 & (**b**) Hecht 9.15

5. Hecht 9.24

6. Hecht 9.32