SIMG-712-01-20042 Homework #5

Due M, 1/31/2005

1. Light of a single wavelength λ_0 illuminates two small apertures in an opaque screen (the apertures can be considered to be points) located at $[x, y] = \left[\pm\frac{d}{2}, 0\right]$. The light travels down the z-axis a distance L where in encounters a screen. The pattern of irradiance on the screen is sinusoidal fringes that vary along the x-axis. Determine the period of the fringes (from maximum to maximum) as a function of L, λ_0, and d.

2. A particular optical system has an aperture shape that is a rectangle with sides of length d_1 and d_2, given by:

$$A(x,y) = \begin{cases} 1 & \textit{if} \quad -\frac{d_1}{2} \leq x \leq +\frac{d_1}{2} \ \textit{and} \ -\frac{d_2}{2} \leq y \leq +\frac{d_2}{2} \\ 0 & \textit{otherwise} \end{cases}$$

   Calculate the irradiance pattern formed by the system imaging a point source at infinity in the Fraunhofer diffraction limit. (Don't worry about the overall scale or normalization, but please do calculate the Fourier integral explicitly.)

3. The diameter of a telescope objective is 120 mm and the focal length is 1500 mm. Light with a mean wavelength of $\lambda = 550\,\text{nm}$ from a distant star enters the telescope as a (nearly) collimated beam. Compute the *radius* of the central disk of light in the image of the star on the focal plane of the lens. Assume no aberrations from the lens or the atmosphere.

4. Assuming that the eye can resolve the image of an object that subtends one arcminute, determine the distance at which a normal eye can see a black circle of diameter 150 mm on a white background.