**Phys 375 – Homework #6**

1) (6 points) A collimated beam of mercury lamp light of wavelength 546.1 nm is normally incident upon a 0.015 cm wide single slit. A screen is placed 90 cm behind the slit. Determine the distance between

a) the central maximum and the first minimum observed on the screen
b) the first and second minima observed on the screen.

2) (3 points) The width of a rectangular slit is measured in the laboratory by means of its diffraction pattern at a distance of 2 meters from the slit. When illuminated normally with a parallel beam of He-Ne laser light (632.8 nm), the distance between the third minima on either side of the principal maximum is measured. An average of several tries gives 5.625 cm. What is the slit width?

3) (3 points) In class we saw that the electric field amplitude for a double slit diffraction pattern is given by

$$E_P = \frac{E_L}{r_0} e^{i(kr_0 - \omega t)} \left[ \int_{-(a+b)/2}^{-(a-b)/2} e^{iks\sin\theta} ds + \int_{(a-b)/2}^{(a+b)/2} e^{iks\sin\theta} ds \right]$$

where a is the slit spacing and b is the slit width. Evaluate the integrals and show that

$$E_P = \frac{2E_L b}{r_0} e^{i(kr_0 - \omega t)} \frac{\sin\beta}{\beta} \cos\alpha$$

where $\alpha = \frac{1}{2} ka \sin\theta, \beta = \frac{1}{2} kb \sin\theta$.

5) (9 points) Sketch the diffraction patterns that you would observe on a screen 100 cm from an aperture illuminated by a He-Ne laser, for the following cases:

a) single slit, slit width = 20 microns.
b) double slit, slit width = 20 microns, slit spacing = 80 microns.
c) four slits, slit width = 20 microns, slit spacing = 80 microns.

Draw these diffraction patterns on a one-to-one scale as you would see them on the screen, and label the position of the first zero due to the "slit width" term.