PHY 431 Homework Set #9

Due December 1 at the start of class

1) ***Newton's rings (30%)***
The radius of curvature of the convex surface of a plano-convex lens is 30 cm. The lens is placed with its convex side down on a plane glass plate, and illuminated from above with red light of wavelength 650 nm.
   A. Find the diameter of the third bright ring in the interference pattern.
   B. Show that for large R this diameter is approximately proportional to $R^{1/2}$.

2) ***Gaussian Beam / Irradiance (30%)***
Compare the irradiances at the retina that result when looking:
A. Directly into the sun. The sun subtends an angle of 0.5 degrees. At the earth surface, the sun's irradiance is $1 kW/m^2$. Assume that the pupil of the bright-adapted eye is 2mm in diameter with focal length of 22.5 mm.
B. Into a 1mW He-Ne laser. Assume the beam waist of the laser is 1mm, and the laser is located 1m from the eye.
C. Which one will damage your eye? Eye-damaging intensities are in the range of $10 W/cm^2$.

3) ***Gaussian Beam and Lens (40%)***
The laser resonator shown in the figure below with z = 0 located at the flat mirror and its output impinges on a lens of focal length 10cm. Assume the beam waist size, w_0=0.5mm; laser wavelength, λ = 632.8nm; and distance of the lens to laser output mirror, d=50 cm.
   A. What is the far-field beam divergence in mrad?
   B. What are the spot size and radius of the curvature of the output laser beam on the lens?
   C. What is the radius of the curvature after passing through the lens?
   D. What is the spot size at the focal point after the lens if the clear aperture of the lens is 1.5cm in radius?
   E. What is the beam radius if the laser beam is propagated 1m further after the focal point? And what is the far-field beam divergence with the lens?

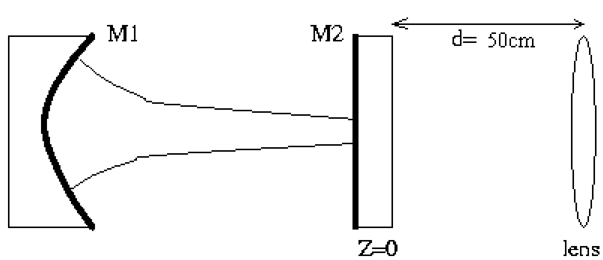

Figure 1

4) ***Optical Apodization (ref. Hecht 11.3.3) – Fourier Optics (*Bonus 0.5 points)***
Optical apodization is the process by which the aperture function of the system is altered to redistribute the energy in the diffraction pattern. To improve the resolution, consider the example where the transmission is modified by a cosine function, cos ($\pi x/b$), between –*b/2*and +*b/2*, where *b* is the slit width. Calculate the position of the n-th minimum of the

single-slit Fraunhofer diffraction pattern, and compare it with the position of the n-th minimum of the unapodized slit of the same width b.