Optics 505  
Exam #2  
April 13, 1999

1) a) (10 Pts) How many elements are in the characteristic matrix?  
b) (10 Pts) What are the boundary conditions used in deriving the characteristic matrix?  
c) (10 Pts) A 3 layer thin film coating is designed to give minimum reflectance at normal incidence for a wavelength of 633 nm. What is the approximate wavelength for minimum reflectance if the light is incident at an angle of 5 degrees from normal incidence? Repeat the question for a coating having 5 layers?

2) (20 Pts) A phase-shifting Fizeau interferometer is used to measure a 2-cm diameter, 500-cm radius of curvature convex spherical mirror. A flat reference surface is used. The wavelength is 633 nm. The interferometer is adjusted to give nearly circular fringes. The detector is a 1 cm square 256 x 256 element CCD array. The spherical surface is imaged onto the CCD array so the diameter of the mirror matches the x and y axes of the CCD. What is the diameter of the portion of the mirror that can be measured before phase-shifting fails?

3) a) (5 Pts) What is the fundamental assumption used in deriving the diffraction equation for the Kirchhoff formulation that is not present in the derivation for the Rayleigh-Sommerfeld formulation? 
b) (5 Pts) Give a physical explanation for the even orders being missing for a binary Fresnel zone plate.  
c) (5 Pts) Interference fringes appear on one side of the Fresnel diffraction of a knife edge. Give a physical explanation for the increase in spatial frequency of the fringes as we move away from the edge of the geometrical shadow.  
d) (5 Pts) As a wave propagates there is a change in the relative phases of the plane wave spectrum. Give a physical explanation of this change in the relative phases.
4) A 1 mm diameter circular aperture is illuminated with a 500 nm wavelength spherical wave diverging from a point source 1 meter to the left of the circular aperture. (See the drawing below.) In the plane of the circular aperture the irradiance of the illuminating beam is 1 watt/cm². What is the on-axis irradiance

a) (10 Pts) 1 meter to the right of the circular aperture?

b) (10 Pts) 1/3 meter to the right of the circular aperture?

c) (10 Pts) Let the circular aperture be replaced with a 1 mm diameter circular obstacle. What is the on-axis irradiance 1 meter to the right of the circular obstacle?