

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

