Optics 505
Exam #2

April 9, 1998

1) (10 Pts) Determine the refractive index and thickness of a film to be deposited on a glass surface (n_g=1.54) such that no normally incident light of wavelength 540 nm is reflected.

2) (15 Pts) I am using phase-shifting interferometry to determine the flatness of a mirror surface. Unfortunately there is a stray reflection in the interferometer that is coherent with respect to the test and reference beams. The stray reflection has 1/25 the intensity of the test beam, the phase of the test beam is 30^o, and the phase of the stray reflection is 90^o. How much phase error will the stray reflection introduce into the measurement of the test beam?

3) (10 Pts) The four integrating bucket phase-shifting technique described in class is used to measure the phase distribution across an interferogram. The interferometer is a Twyman-Green with a helium neon laser as the light source. The detector used contains 100 X 100 detector elements. The detector is read out at a rate of 10^6 detector elements per second. Assume the detector can be read out continuously with no dead time. Let the phase shifter be a moving mirror mounted on a piezoelectric transducer. How fast must the mirror be moving during the taking of the data? Give velocity in units of microns per second.

4) Plane waves having a wavelength of 624 nm impinge normally on a circular aperture 2.09-mm in radius. The resulting diffraction pattern is observed on a screen 1 m from the aperture.

   a) (10 Pts) How many Fresnel zones are contained within the aperture?

   b) (10 Pts) Is the central spot in the diffraction pattern bright or dark? Explain.

5) a) (10 Pts) Fresnel integrals are used for determining Fresnel diffraction for certain types of apertures. What are these apertures?

   b) (10 Pts) A Fresnel zone plate has a focal length of 10 cm for a wavelength of 500 nm. What is the focal length for a wavelength of 633 nm?

   c) (10 Pts) A circular obstacle 1.266-mm in diameter is illuminated with a quasi-monochromatic plane wave having an irradiance of 5 watts/cm^2 and a wavelength of 633 nm. What is the on-axis irradiance 48-cm from the obstacle?

6) (15 Pts) In a plane z=0 the amplitude transmittance of a screen is

$$t[x, y] = \frac{1}{2}\left(1 + 0.4\,\text{Cos}\left[\frac{2\pi}{\lambda}\,0.05\,x\right]\right)$$

Assume normally incident plane wave illumination of 5 watts/cm^2 and neglect the finite aperture extent. What is the irradiance of the Fresnel diffraction pattern of the screen at a distance of 800 λ?