Optics 505
Exam #2

**April 10, 1997**

1) The characteristic matrix is very useful in analyzing multilayer films.

    a) (5 Pts) How many elements are in the characteristic matrix?

    b) (5 Pts) What does the characteristic matrix relate?

    c) (5 Pts) What boundary conditions are used in deriving the characteristic matrix?

    d) (10 Pts) An AR coating is designed for a 600 nm wavelength at normal incidence. What is the approximate wavelength for minimum reflectance if the angle of incidence is changed to 5 degrees?

2) a) (15 Pts) A Twyman Green interferometer using phase-shifting interferometry is used to measure the flatness of a 10 cm diameter flat mirror at a wavelength of 500 nm. The 256 x 256 element CCD array used in the interferometer is 1 cm square. The image of the mirror falling on the detector fills the detector array. The reference mirror is first tilted such that a single fringe covers the detector. The test mirror is now tilted so the fringes are parallel to the columns of detector elements. How much must the test mirror be tilted (in units of milli-radians) such that the fringes become so close together that phase-shifting fails to work?

    b) (10 Pts) Sketch the above setup showing all important components.

3) A zone plate transmits 100% of the incident light, and every other zone is covered with a thin film of thickness d and refractive index 1.5. The zone plate has a focal length of 10 cm for a wavelength of 550 nm.

    a) (5 Pts) What is the smallest d such that the zone plate has no zero order for a wavelength of 550 nm?

    b) (10 Pts) What is the smallest d such that the zone plate has no zero order for wavelengths of 550 nm and 450 nm.

    c) The zone plate is illuminated with a spherical wave coming from a source 5 cm to the left of the plate. Where do the two first orders come to focus for a wavelength of

        i) (5 Pts) 550 nm?

        ii) (5 Pts) 450 nm?

4) a) A 1 mm diameter circular obstacle is illuminated with a spherical wave diverging from a point source 1 meter to the left of the circular obstacle. In the plane of the circular obstacle the irradiance of the illuminating beam is 1 watt/cm^2. What is the on-axis irradiance

      i) (10 Pts) 1 meter to the right of the circular obstacle?

      ii) (5 Pts) 2 meters to the right of the circular obstacle?

Obstacle

Source

1 m   1 m   1 m
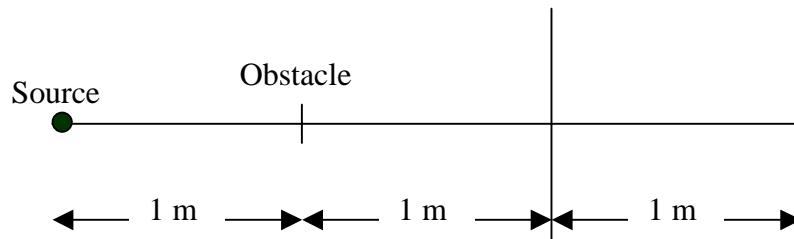
b) (10 Pts) Sketch the Fresnel diffraction pattern of a knife edge where the knife transmits 100 percent, but introduces a 180 degree phase change for the light transmitted through the knife.