D-C1) A zone plate is made by interfering a plane wave and a spherical wave of wavelength 650 nm. Let the distance from the zone plate to the point source be 20 cm.

a) Where do the two first orders ($n = \pm 1$) come to focus if the zone plate is illuminated with a plane wave of wavelength 500 nm? Where do the two third orders ($n = \pm 3$) come to focus?

b) Where do the two first orders ($n = \pm 1$) come to focus if the zone plate is illuminated with a 25 cm radius of curvature spherical wavefront of wavelength 633 nm?

D-C2) A monochromatic point source S emits light of wavelength 633 nm. It falls onto an aperture A 15 cm away and then onto a screen 20 cm beyond A.

a) What is the value of the radius of the first Fresnel half-period zone at A?

b) The aperture A is a circle of radius 1 cm. How many Fresnel half-period zones does it contain?

c) A Fresnel zone plate is made with vertical polarizers covering the odd zones and horizontal polarizers covering the even zones. How does its behavior compare with a conventional zone plate with even zones opaque and odd zones transparent?

D-C3) A 1 mm diameter hole is illuminated with a $\lambda = 600$ nm normally incident plane wave.

a.) Sketch the on-axis irradiance from $z= 0.1$ m to $z = 0.25$ m, indicating the positions of odd and even Fresnel numbers.

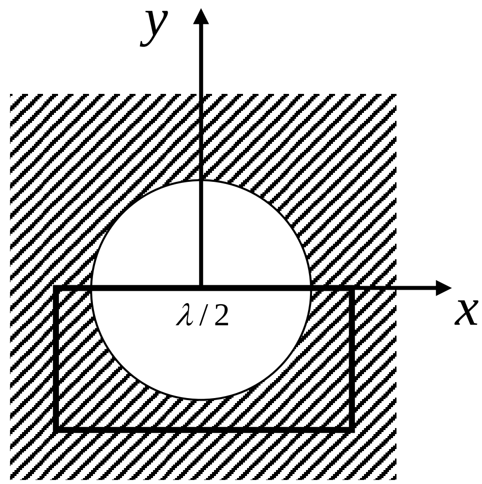
b.) Sketch the transverse irradiance profiles at each integer Fresnel number in part (a). Indicate the geometrical boundary in your sketch.

c.) How would the on-axis irradiance of part (a) change for the following cases. Draw a rough sketch indicating the envelope of the modulation. Also indicate whether the peak locations shift toward the hole or away from it.

i.) diverging illumination ($z_1 = 10$ m)?

ii.) converging illumination ($z_1$=-10 m)?

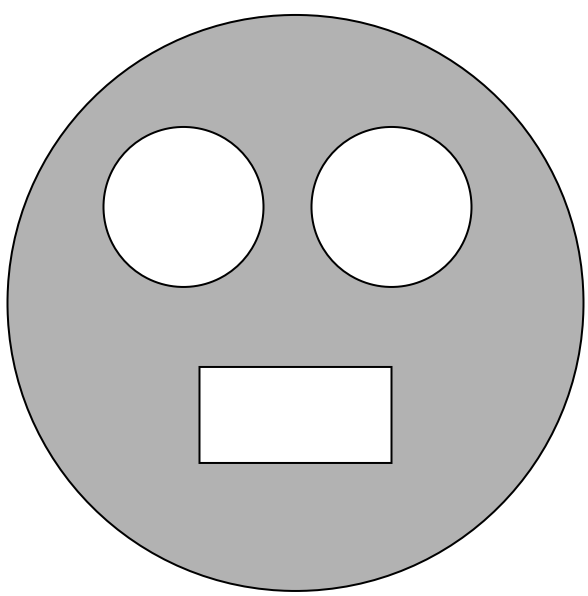
D-C4) Consider the 1 mm diameter hole of Problem (4), where a $\lambda/2$ plate is placed so that it covers exactly half of the open area, as shown below.



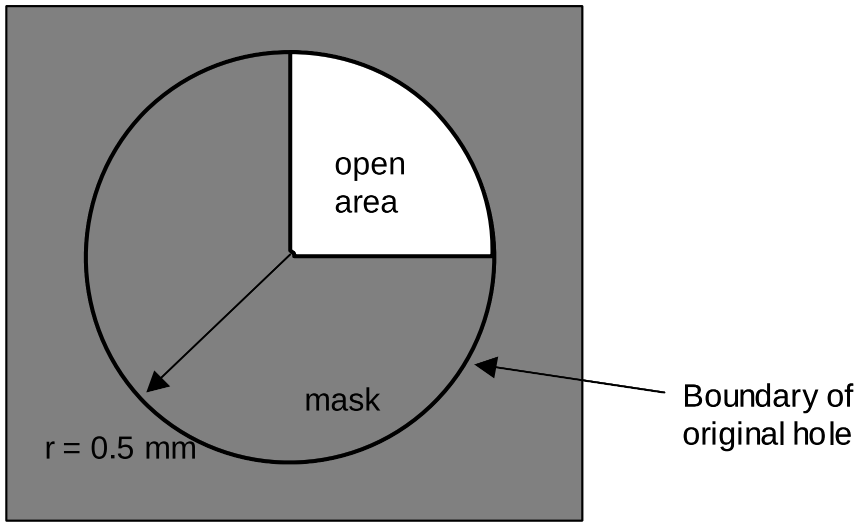

a.) Sketch the on-axis irradiance from $z$ = 0.1 m to $z$ = 0.25 m.

b.) Draw a rough sketch of the transverse irradiance profile along $y$ = 0 at $z$ = 0.1 m.

D-C5) It is desired to find the near-field diffraction pattern of the screen sketched below. The shaded area is opaque. Using aperture algebra, graphically show how the calculation can be achieved using combinations of results from circular holes and rectangles. Only one feature (hole or rectangle) is allowed per component of the calculation. The features can be shifted.



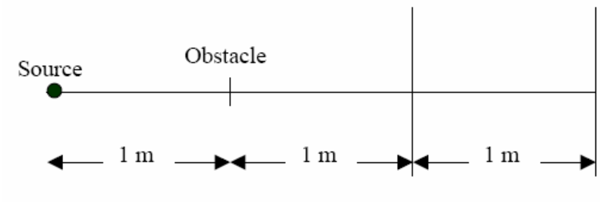
D-C6) A 1 mm diameter hole is illuminated with a normally incident plane wave at 1 $W/cm^2$ and $\lambda$ = 500 nm. The aperture is modified by an opaque mask, as shown below, which covers 75% of the hole.




a.) What is the on-axis irradiance at a distance of 0.167 m behind the aperture?
b.) What is the on-axis irradiance at a distance of 0.125 m behind the aperture?
c.) Briefly describe how to calculate the off-axis irradiance pattern.

D-B11) 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/cm2. What is the on-axis irradiance.

a.) (10 pts) 1 meter to the right of the circular obstacle?
b.) (5 pts) 2 meters to the right of the circular obstacle?




D-B12) A 100 μm pitch amplitude grating is illuminated by two collimated laser beams at normal incidence. The laser wavelengths are 400 nm and 800 nm. What observation is made at a distance of 12.5 mm from the grating? The transmittance of the grating is ($m$ <<1, D = 50μm):

$$t(x_1) = 1 + m\frac{1}{D}rect\left(\frac{x_1}{D}\right) * \frac{1}{2D}comb\left(\frac{x_1}{2D}\right).$$