Optics Exercise V

2019

Problem 1

A point source S is at perpendicular distance R away from the center of a circular hole of radius *a* in an opaque screen. If the distance to the periphery is (R +l), show that Fraunhofer diffraction will occur on a very distant screen when

$$\lambda R \gg a^2/2$$

What is the smallest satisfactory value of R if the hole has a radius of 1 mm, $l \leq \lambda/10$, and λ = 500 nm?

Problem 2

What is the relative irradiance of the subsidiary maxima in a three-slit Fraunhofer diffraction pattern? Draw a graph of the irradiance distribution, when a = 2b, for two and then three slits.

Problem 3

No lens can focus light down to a perfect point because there will always be some diffraction. Estimate the size of the minimum spot of light that can be expected at the focus of a lens. Discuss the relationship among the focal length, the lens diameter, and the spot size. Take the f-number of the lens to be roughly 0.8 or 0.9, which is just about what you can expect for a fast lens.

Problem 4

A diffraction grating with slits 0.60×10−3 cm apart is illuminated by light with a wavelength of 500 nm. At what angle will the third-order maximum appear?

Problem 5

Light from a laboratory sodium lamp has two strong yellow components at 589.5923 nm and 588.9953 nm. How far apart in the first-order spectrum will these two lines be on a screen 1.00 m from a grating having 10000 lines per centimeter?

Problem 6

A high-resolution grating 260 mm wide, with 300 lines per millimeter, at about 75◦ in auto-collimation has a resolving power of just about 106 for λ = 500 nm. Find its free spectral range. How do these values of R and $(\Delta\lambda)_{fsr}$ compare with those of a Fabry-Perot etalon having a 1 cm air gap and a finesse of 25?