

1. (Do this problem in 1 dimension) Figure 1 below shows an opaque screen with three identical apertures of width a and separation d between adjacent apertures. The system is illuminated by a monochromatic, spatially coherent plane wave incident on-axis. The Fraunhofer diffraction pattern is observed at a sufficient distance l away from the object. We are given the freedom to place glass plates of arbitrary thickness inside the apertures to manage the relative phase delay between the fields passing from the apertures. (The phase delay must be uniform within each aperture.)
 - 1.a) Devise a set of phase delays between the apertures that result in deconstructive interference on-axis in the Fraunhofer zone. (The axis is the line passing through the central hole, as shown in the figure.)
 - 1.b) Point out an analogy to this problem from the fields of mechanics of electrical circuits.
 - 1.c) Derive and plot the intensity of the entire Fraunhofer diffraction pattern for your choice of phase delays.

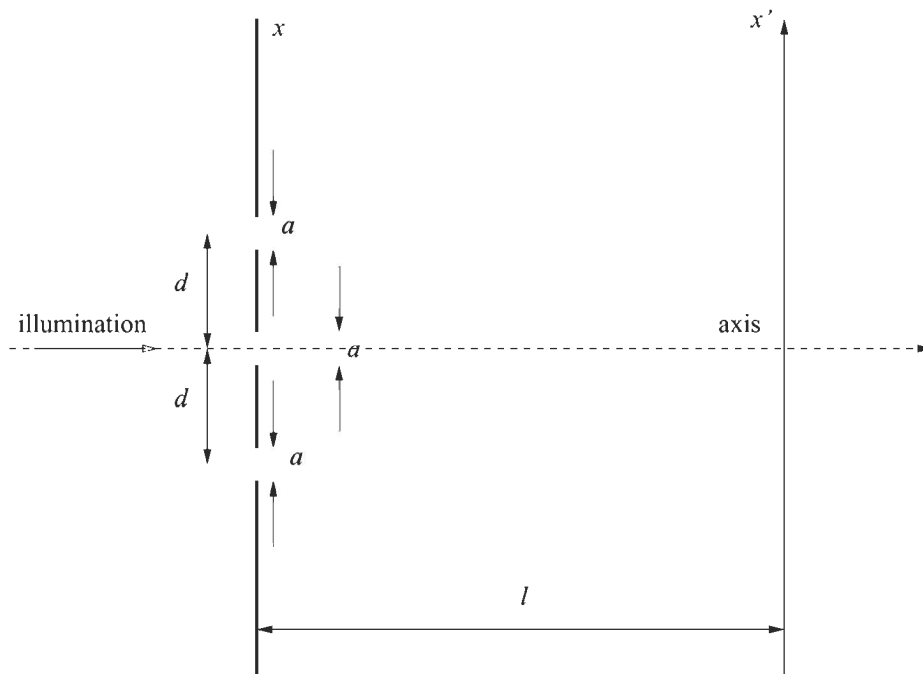


Figure 1

2. An infinite periodic square-wave grating with transmittivity as shown in Figure 2A is placed at the input of the optical system of Figure 2B. Both lenses are positive, $F/1$, and have focal length f . The grating is illuminated with monochromatic, spatially coherent light of wavelength λ and intensity I_0 . The spatial period of the grating is $X = 4\lambda$. The element at the Fourier plane of the system is a nonlinear transparency with the intensity transmission function shown in Figure 2C, where the threshold and saturating intensities $I_{\text{thr}} = I_{\text{sat}} = 0.1I_0$.

2.a) To carry out the calculation analytically, you need to neglect the Airy patterns forming at the Fourier plane and pretend they are uniform bright dots. Explain why this assumption is justified and what effects it might have.

2.b) Derive and plot the intensity distribution at the output plane using above assumption.

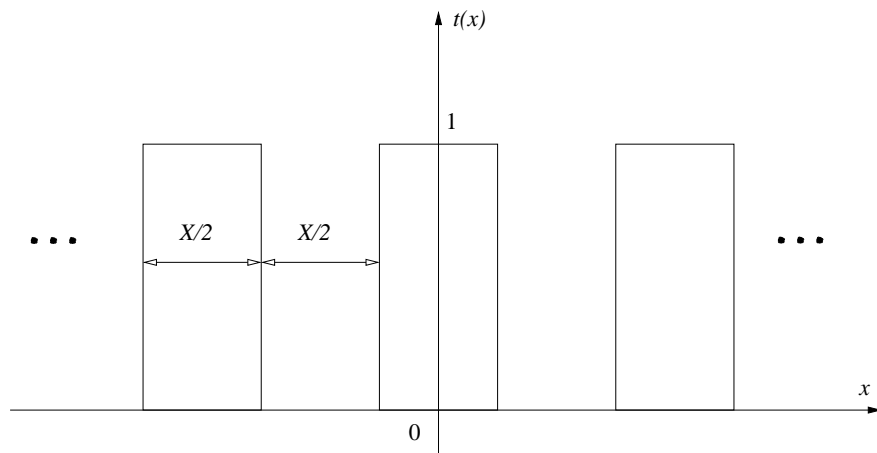


Figure 2A

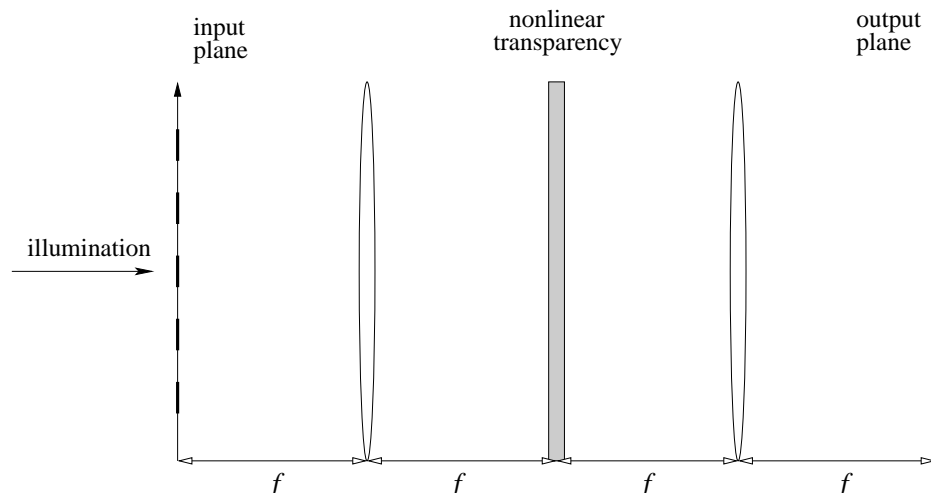


Figure 2B

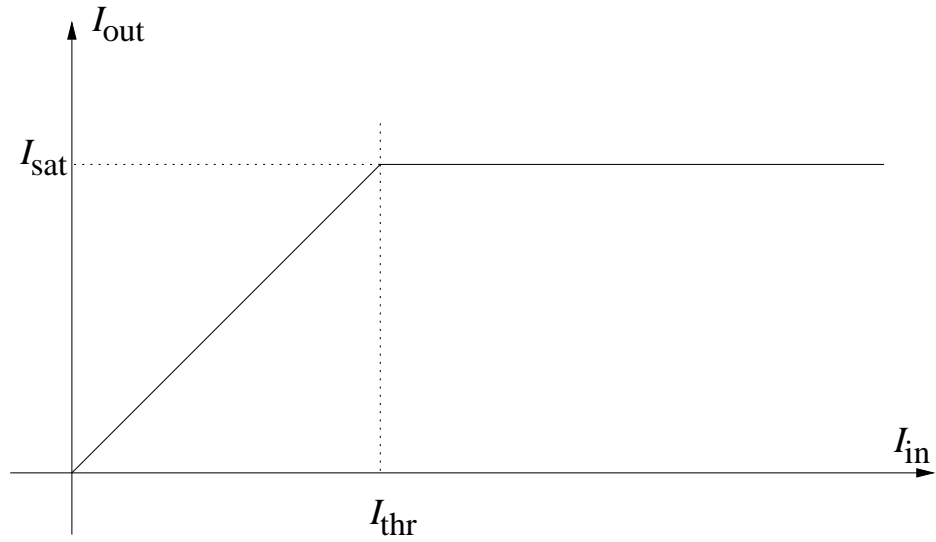


Figure 2C

3. Sketch cross-sections of the optical transfer function along the spatial frequency axes f_x, f_y for an incoherent imaging system having a pupil function as the two-pinhole combination shown in Figure 3. Assume $w < d$. Do *not* use MATLAB for this calculation. Explain briefly the appearance of your sketches, and be sure to label the various cutoff frequencies and center frequencies.

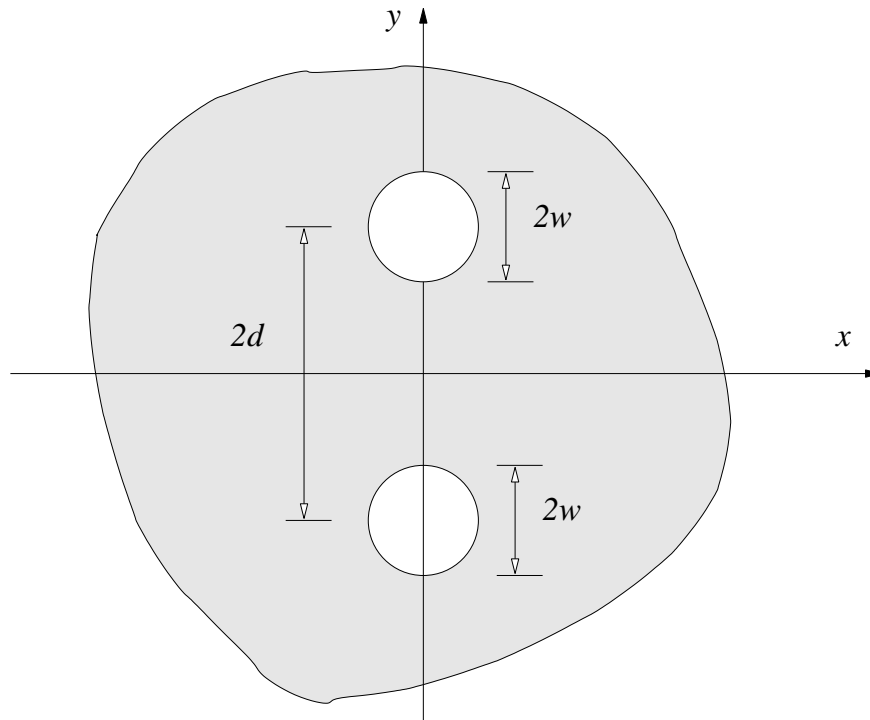


Figure 3