1. Suppose an opaque screen contains an array of identical small holes. A single hole has a Fourier transform $F_1(\nu_x, \nu_y)$. If $N$ holes are lined up along the $x$-axis with spacing $B$ as shown, calculate the Fraunhofer diffraction pattern for the array. Sketch the intensity along $x$, assuming that $N$ is large and that $F_1$ is a smooth function of $\nu_x$ with width $\Delta \nu_x \gg 1/B$.

![Array of holes](image)

2. Saleh and Teich, Problem 4.4-2, page 154. Include a sketch of $I_{\text{out}}(x)$. Hints: Remember that the impulse response function $h(x, y)$ is defined so that

$$g(x, y) = \int \int f(x', y')h(x - x', y - y')dx'dy'$$

The function rect$(x)$ is defined to be zero for $|x| \geq 1/2$ and one for $|x| < 1/2$. The delta function $\delta(y)$ has the property

$$\int f(x', y')\delta(y - y')dy' = f(x', y)$$

so the $y$ integration is trivial.

3. Suppose a focused imaging system, such as that shown in Figure 4.4-8 on page 141, is used to image two point sources. The magnification is such that the two images are a distance $B$ apart. For large $B$, the points will be resolved and the image shows two distinct peaks. For small $B$, the points are not resolved and the image shows only one peak. In terms of the wavelength $\lambda$, the diameter of the lens $D$, and the image distance $d_2$, determine the value of $B$ separating these two regimes. Find an answer accurate to within 2%:

(a) Assuming the two points are mutually coherent. For instance, they might be two tiny holes in a screen illuminated by a plane wave.

(b) Assuming the two points are mutually incoherent. For instance, they might be two distant stars (observed through a filter that transmits only light of wavelength $\lambda$). This prevents the two waves from interfering.

A computer program capable of plotting Bessel functions will be useful for this problem.