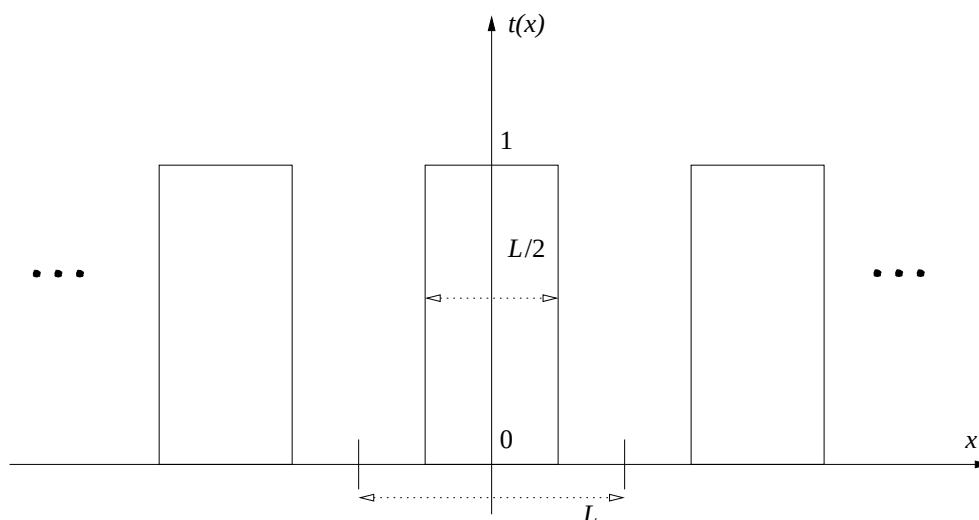
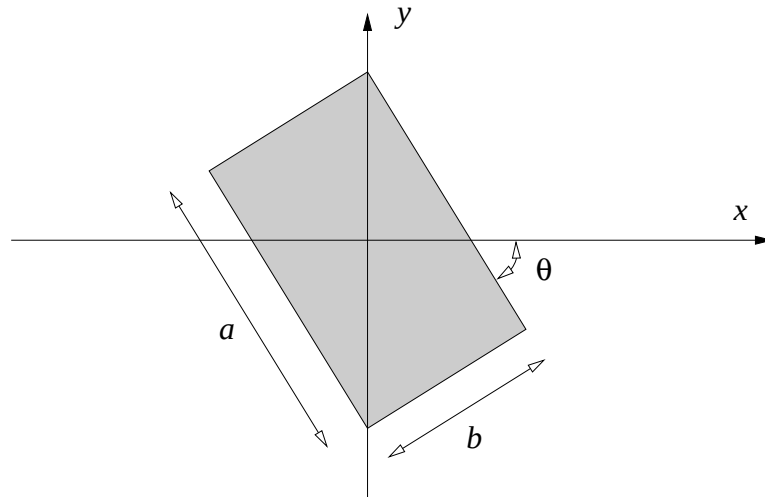


**2.71 Optics****Fall '05**Problem Set #7    Posted Wednesday, Nov. 2, 2005 — Due Wednesday, Nov. 9, 2005

1. A spherical wave is incident on a Fabry-Perot cavity interferometer implemented as a dielectric slab of index  $n$ . The wavelength of the spherical wave in vacuum is  $\lambda$ . The spherical wave originates a distance  $d = 10^3\lambda$  to the left of the front face of the cavity. The cavity length is  $L = 10\lambda/n$  and the intensity reflection coefficient of each face of the cavity is  $R = 0.95$ . Describe the interference pattern that would be observed on a screen placed a very small distance to the right of the back face of the cavity.
2. Consider the one-dimensional periodic function shown below. In the field of Optics, this is often referred to as a “Binary grating” of infinite extent.
  - 2.a) Calculate the Fourier series coefficients of that periodic function in closed form.
  - 2.b) Write down the Fourier transform of a single boxcar, *i.e.* a single period of this function. What do you observe?



3. **Tilted aperture.** Calculate analytically and sketch the Fourier transform of the tilted aperture shown below (the aperture has value one inside the tilted rectangle and zero outside). The edge lengths are  $a = 10\mu\text{m}$ ,  $b = 5\mu\text{m}$  and the tilt is  $\theta = 60^\circ$ . *Hint:* First calculate the Fourier transform of the same aperture oriented upright; then rotate the  $(x, y)$  coordinates.



4. **Tilted binary grating.** Calculate analytically and sketch the Fourier transform of the limited-aperture grating shown below (the aperture has value one at the locations shown as white and zero everywhere else.) Assume spatial period  $\Lambda = 10\mu\text{m}$ , stripe size  $d = 2\mu\text{m}$ , tilt  $\theta = 30^\circ$  with respect to the aperture, and edge lengths  $a = 5\text{mm}$ ,  $b = 3\text{mm}$ . *Hint:* First calculate the Fourier transforms of the tilted grating and the aperture individually. Then use the convolution theorem.

