MASSACHUSETTS INSTITUTE OF TECHNOLOGY

**2.710 Optics** **Fall '05**

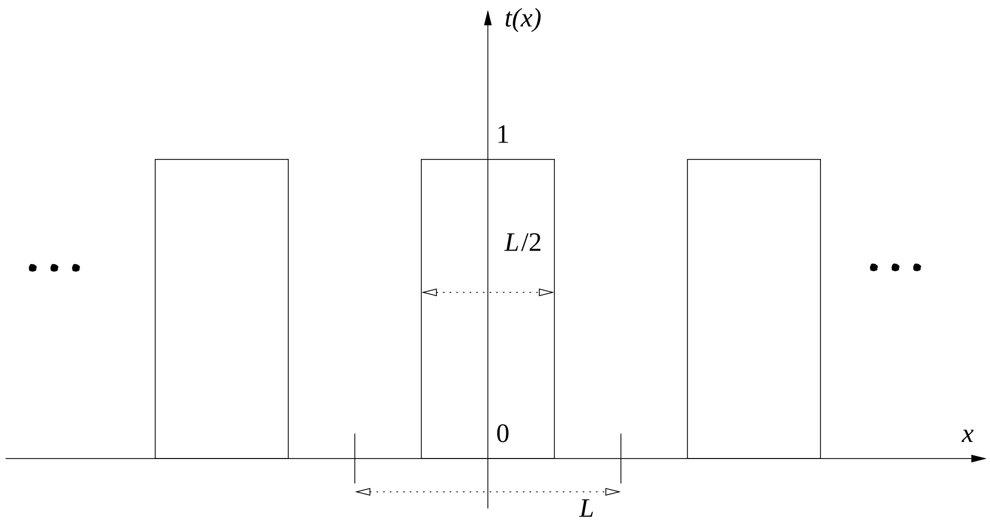
Problem Set #7 Posted Wednesday, Nov. 2, 2005 — Due Wednesday, Nov. 9, 2005

**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.

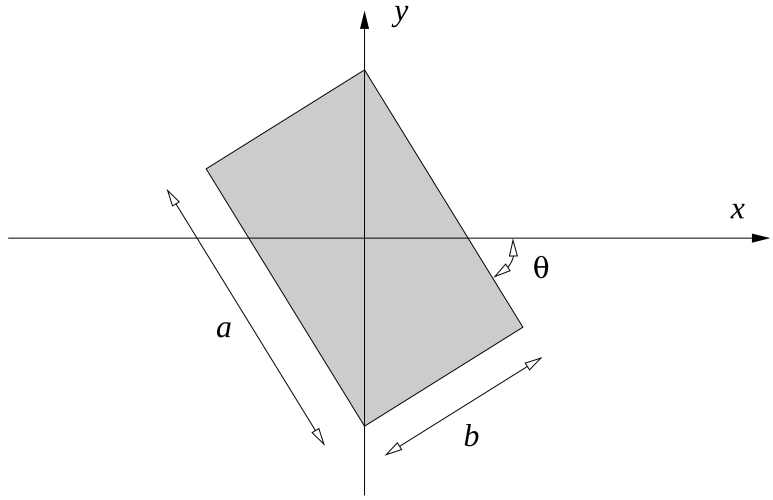
**2.** Consider the one-dimensional periodic function shown below. In the field of Optics, this is often refered as a "Binary grating" of infinite extent.

**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 $a = 10\mu$m, $b = 5\mu$m and the tilt is $\theta = 60°$. *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 $\theta = 30°$ 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.