1. What is the Fraunhofer diffraction pattern of a 1-D slit of size a?

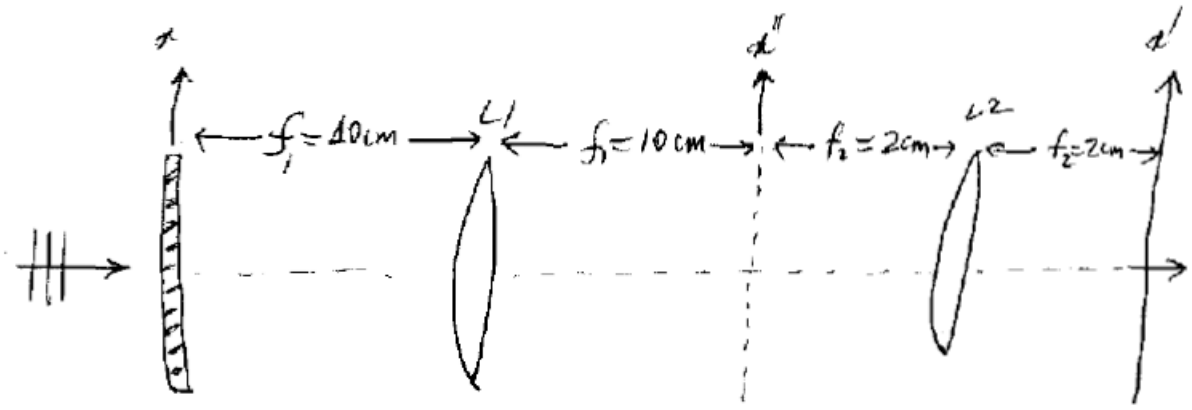
2. What is the Fraunhofer diffraction pattern of this sinusoidal amplitude grating, where Λ is the grating period?
$$f(x) = \frac{1}{2}\left[1 + \cos\left(2\pi\frac{x}{\Lambda}\right)\right]$$

3. How does the result of problem 2 change if the illumination is a plane wave incident at angle θ_0 with respect to the optical axis? ($\theta_0 << 1$)

4. What is the Fraunhofer pattern of this truncated sinusoidal amplitude grating? Assume that $a >> \Lambda$.
$$f(x) = \frac{1}{2}\left[1 + \cos\left(2\pi\frac{x}{\Lambda}\right)\right] \text{rect}\left(\frac{x}{a}\right)$$

5. What is the Fraunhofer diffraction pattern of two identical slits (width a) separated by a distance $d >> a$?

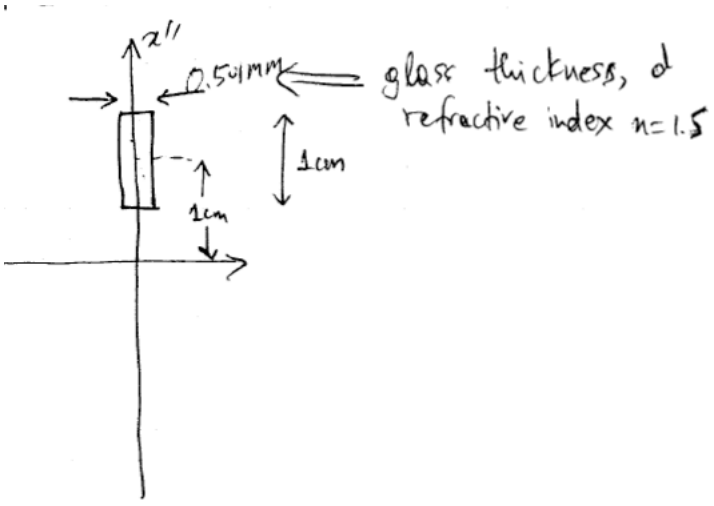
6. In the 4F system shown below, the sinusoidal transparency $t(x)$ is illuminated by a monochromatic plane wave on-axis, at wavelength $\lambda = 1\mu$m. Describe quantitatively the fields at the Fourier plane (x'') and the output plane (x').
$$t(x) = \frac{1}{2}\left[1 + \cos\left(2\pi\frac{x}{10\mu m}\right)\right]$$



7. Repeat the calculations of problem 6, except this time with illumination of a tilted plane wave incident at angle $\theta = 0.25$ rad with respect to the optical axis.

8. Repeat problem 7 with a truncated grating of size 1 mm.

9. In the optical system of problem 6 (infinitely large grating, on-axis plane wave illumination) we place a small piece of glass at the Fourier plane as follows:



What is the output field? What is the output intensity?

10. Consider the 4F optical system shown in Figure B, where lenses L1, L2 are identical with focal length f. A thin transparency with arbitrary transmission function $t(x)$ is placed at the input plane of the system, and illuminated with a monochromatic, coherent plane wave at wavelength λ, incident on-axis. At the Fourier plane of the system we place the amplitude filter shown in Figure C. The filter is opaque everywhere except over two thin stripes of width a, located symmetrically around the y'' axis. The distance between the stripe centers is $x_0 > a$.

    (a) Which range of spatial frequencies must $t(x)$ contain for the system to transmit any light to its image plane?

    (b) Write an expression for the field at the image plane as the convolution of $t(x)$ with the coherent impulse response of this system.

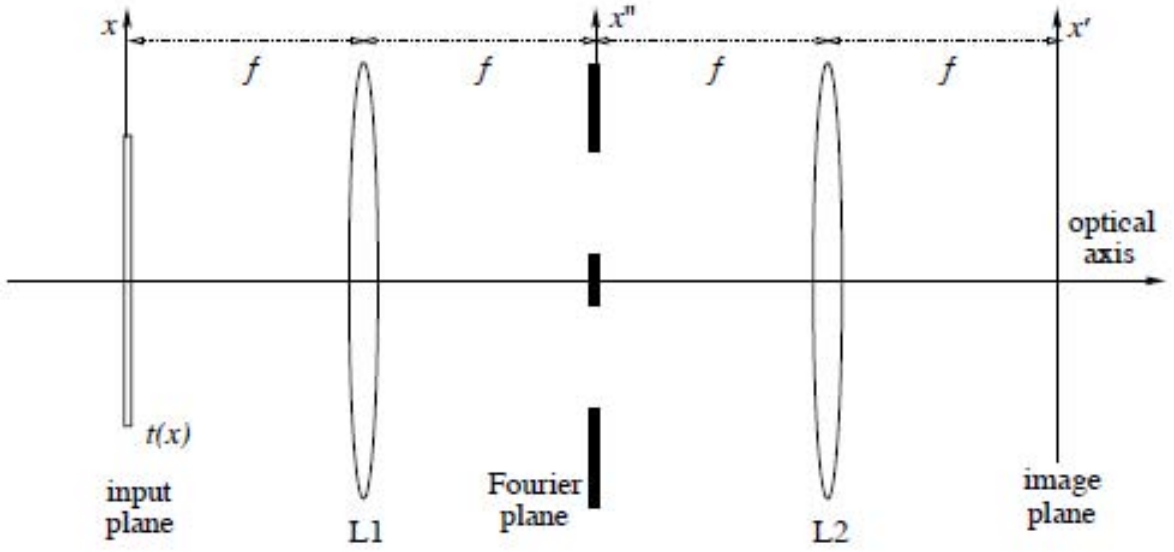


Figure B

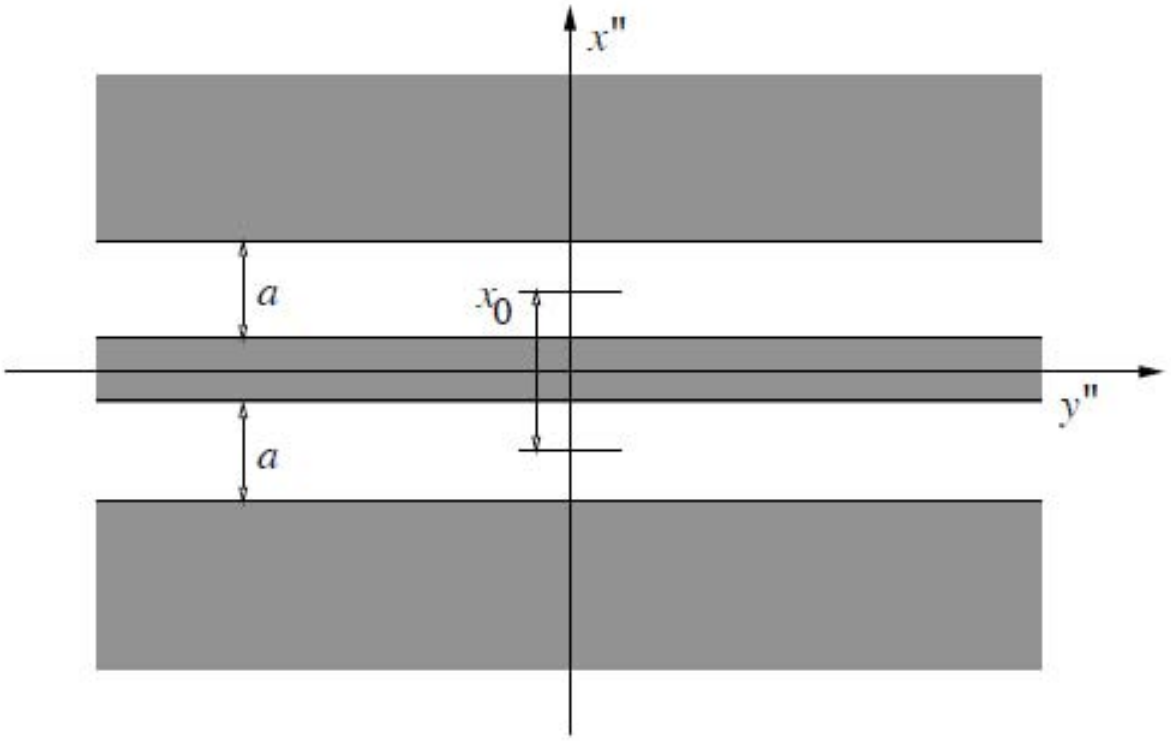


Figure C

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