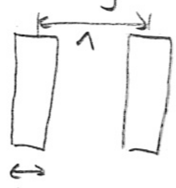
Project 2

Initial Field $E =$ [Gaussian] [Passing sections]

Treat passing sections as a grating

Passing sections $= \text{rect}() \otimes \text{comb}()$



Passing sections : $P(x) = \text{rect}\left(\frac{x}{F\Lambda}\right) \otimes \text{comb}\left(\frac{x}{\Lambda}\right)$

Gaussian: $E_g(x) = \exp\left(-\left(\frac{x}{10^{-3}}\right)^2\right)$

From table $E_g(x) = \exp(-\pi x^2)$

$$-\pi (ax)^2 = -\left(\frac{x}{10^{-3}}\right)^2$$

$$\sqrt{\pi}\, ax = \frac{x}{10^{-3}}$$

$$a = \frac{1}{\sqrt{\pi}\, 10^{-3}}$$

$$E_g\left(\frac{x}{\sqrt{\pi}\, 10^{-3}}\right) = \exp\left(-\frac{\pi}{\pi}\left(\frac{x}{10^{-3}}\right)^2\right)$$

$$e_i = \left[E_g\left(\frac{x}{\sqrt{\pi}\, 10^{-3}}\right)\right]\left[\text{rect}\left(\frac{x}{F\Lambda}\right) \otimes \text{comb}\left(\frac{x}{\Lambda}\right)\right]$$

Now take Fourier transform (ignoring amplitude terms)

$$E = \left[\exp\left(-\pi\left(\sqrt{\pi}\, 10^{-3} f_x\right)^2\right)\right] \otimes \left[\text{Sinc}(F\Lambda f_x) \sum \delta(\Lambda f_x - n)\right]$$

$$= \exp\left(-\left(\pi\, 10^{-3} f_x\right)^2\right) \otimes \left[\text{Sinc}(F\Lambda f_x) \sum \delta\left(f_x - \frac{n}{\Lambda}\right)\right]$$

$$E_f(f_x) = \sum_{n=-\infty}^{\infty} \int_{-\infty}^{\infty} \exp\left(-\left(\pi\, 10^{-3}\, \tau\right)^2\right) \text{Sinc}\left[F\Lambda(f_x - \tau)\right] \delta\left(f_x - \tau - \frac{n}{\Lambda}\right) d\tau$$

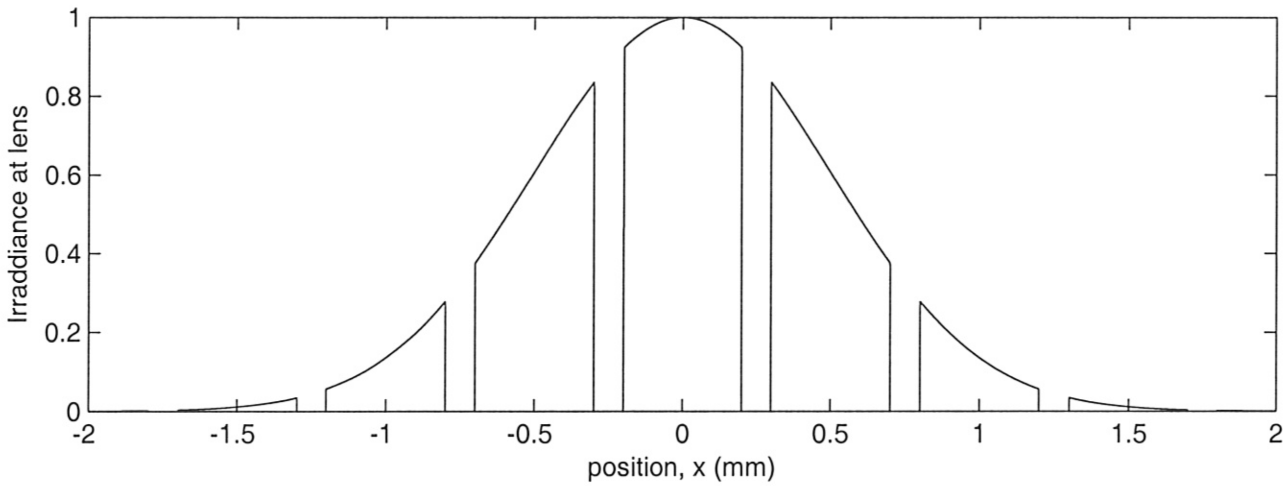
Evaluate at $f_x - \tau - \frac{n}{\Lambda} = 0$

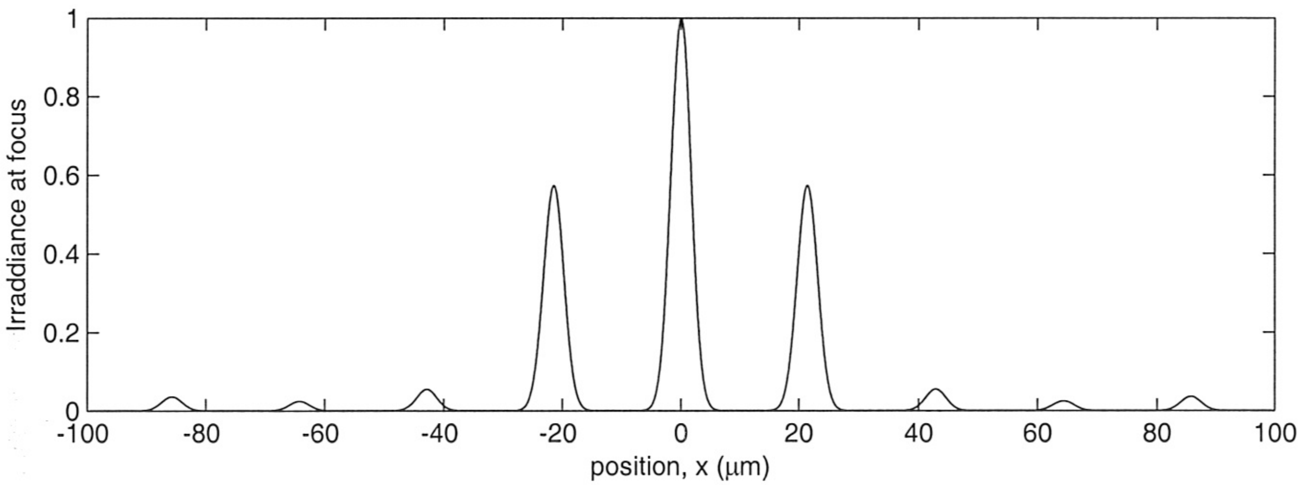
$\tau = f_x - \frac{n}{\Lambda}$

$$E_f(f_x) = \sum_{n=-\infty}^{\infty} \exp\left[-\left(\pi\, 10^{-3}\left(f_x - \frac{n}{\Lambda}\right)\right)^2\right] \text{Sinc}\left(F\Lambda \frac{n}{\Lambda}\right)$$

$$E_f(x) = \sum_{n=-\infty}^{\infty} \exp\left[-\left(\pi\, 10^{-3}\left(\frac{x}{\lambda f} - \frac{n}{\Lambda}\right)\right)^2\right] \text{Sinc}(Fn)$$

$$= \sum_{n=-\infty}^{\infty} \text{Sinc}(Fn) \exp\left[-\left[\left(\frac{\pi\, 10^{-3}}{\lambda f}\right)\left(x - n\frac{\lambda f}{\Lambda}\right)\right]^2\right]$$


Irradiance at lens
position, x (mm)
1
0.8
0.6
0.4
0.2
0
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2


Irradiance at focus
position, x (μm)
1
0.8
0.6
0.4
0.2
0
-100
-80
-60
-40
-20
0
20
40
60
80
100