Quiz #5 Sol. 11/12/2018

1. Fraunhofer diffraction criterion: $\frac{\delta}{d} \ll \lambda$; $\frac{1}{2}\left(\frac{1}{d}+\frac{1}{d'}\right)\delta^2 \ll \lambda$

→ $\lambda = 600\ nm$, $\delta = 1\ mm$

$d' = 10\ m$, $d =$ (a) $1\ cm$

(b) $1\ m$

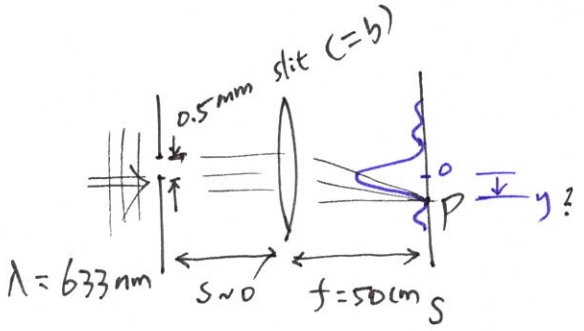
(a) $\frac{1}{d}+\frac{1}{d'} = \frac{1}{0.01}+\frac{1}{5} = 100.2$; $\delta^2 = 10^{-6}\ (m^2)$

$\therefore \left(\frac{1}{2}\right)\left(10^{-6}\right)(100.2) \doteq 50\ (\mu m) \gg 600\ nm$ → Fresnel

(b) $\frac{1}{d}+\frac{1}{d'} = \frac{1}{1}+\frac{1}{5} = 0.7$

$\therefore \left(\frac{1}{1}\right)(0.7)\left(10^{-6}\right) = 0.7\ \mu m > 600\ nm$ → Fresnel

2.



$I = I_0\left(\frac{\sin\beta}{\beta}\right)^2$,

$\beta = \frac{1}{2}kb\sin\theta$

For $I = 0$, $\beta = \pm\pi$

$\therefore \sin\theta = \pm 2\pi/kb = \pm\frac{2\pi}{2\pi}\frac{\lambda}{b} = \pm\frac{\lambda}{b}$

Because the lens is placed just behind the slit,

$\sin\theta \approx \frac{y}{f}$ $\therefore y = f\left(\frac{\lambda}{b}\right) = (0.5)\left(\frac{6.33\times10^{-7}}{5\times10^{-4}}\right)$

$= 0.633\ (mm)$