HW 6

1-2) at grazing $\psi_0 \; t(x)$

$$ = \int \frac{d}{dx} \psi_0 (q_x) e^{i q_x x} \sum p \frac{e^{i \frac{2\pi p x}{d}}}{p} \int \frac{d}{dx} \psi_0 (q_x) e^{i \left(q_x \frac{2\pi p}{d}\right) x}$$

$$= \sum p \frac{e^{i \frac{2\pi p x}{d}}}{p} \int \psi_0 (q_x) e^{i \left(q_x \frac{2\pi p}{d}\right) x}$$

$$= \sum p \frac{e^{i \frac{2\pi p x}{d}}}{p} \int \psi_0 (k - \frac{2\pi p}{d}) e^{i k x}$$

= sum of waves moving in direction $k_x' = \frac{2\pi p}{d}$ with amplitude $e^{i \frac{2\pi p x}{d}}$

so intensity in direction $k_x' = \frac{2\pi p}{d}$ is $|e^{i \frac{2\pi p x}{d}}|^2$

just as in our other treatment in class.

3) 780 nm, 800 lines/mm, 500 nm blaze

1st order diffraction angle @ 500 nm

$$\sin \theta = \frac{\lambda}{d} = \frac{500 \text{ nm}}{800 \text{ mm}} = 0.00625 \Rightarrow \theta = 0.35^\circ$$

So, the grooves are angled @ $0.35^\circ = \alpha$

Single slit diffraction

$$\sin^2 \left( \frac{\theta - \tan \theta}{2} \right) = \sin^2 \left( \frac{0.35^\circ}{2} \right) = \sin^2 \left( 0.2^\circ \right) = 0.045$$
From class

$$|\ell| = \sin \frac{c}{\ell} \left( \pi \phi - \frac{\pi d}{\lambda} \tan(1 + \cos \phi) \right)$$

$$= \sin \frac{c}{\ell} \left( \pi \phi - \frac{1.25 \mu m \tan(11.8^\circ)}{0.78} (1 + \cos \phi) \right)$$

<table>
<thead>
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<th>$\phi$</th>
<th>$\theta$</th>
<th>$\sin \frac{c}{\ell}$</th>
</tr>
</thead>
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<tr>
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<tr>
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</tr>
<tr>
<td>-1</td>
<td>-35.6</td>
<td>0.036</td>
</tr>
</tbody>
</table>

$\Rightarrow 22\%$
$\Rightarrow 73\%$
$\Rightarrow 59\%$

5) Block 4.8

Two lenses make an image of input slit onto exit plane.

As we scan the exit slit, which is the same size (assuming unit magnification), we therefore have the convolution of two square functions of width $w$ which gives

Image of input slit
6) Brooker
4.11 (1)

\[ \text{Finesse} = \frac{\text{separation between orders}}{\text{width}} \]

\[ \Delta \theta = \frac{\Delta p}{Nd \cos \theta} \]

\[ \text{width} \quad \Delta \theta \quad \rightarrow \quad X_d \]

\[ \sin \theta \]

\[ \cos \theta \Delta \theta = \frac{\Delta}{Nd} = \Delta (\sin \theta) \]

\[ \Delta \}

\[ \text{Finesse} = \frac{X_d}{\Delta X_d} = N \]