# Problem Set 6

PHYSICS 443
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1. Given the parameters

$$\begin{aligned}\lambda &= 589\,\text{nm}\\ s &= 2.25\,\text{m}\\ \Delta y &= 0.5\,\text{cm}\end{aligned}$$

The distance between the slits $a$ is found as

$$\begin{aligned}\Delta y &\approx \frac{s}{a}\lambda\\ a &= \frac{s}{\Delta y}\lambda\\ &= \frac{2.25}{0.5\times 10^{-2}}589\times 10^{-9} \qquad [\text{m}]\\ &= 265\,\mu\text{m}\end{aligned}$$

2. From the derivation in-class, we can pick a coating with index of refraction

$$n_2 = \sqrt{1.5} = 1.22$$

The coating thickness can have a thickness

$$d = (2m+1)\,\pi\frac{\lambda_0}{4\pi n_2}$$

For $m = 2$,

$$\begin{aligned}d_2 &= 5\pi\frac{800\,\text{nm}}{4\pi 1.22}\\ &= 833\,\text{nm}\end{aligned}$$

3. For a reflectance of $R = 0.99$, the finesse is

$$\mathscr{F} = \frac{\pi}{2}\frac{2\sqrt{0.99}}{(1-0.99)} \approx 312.6$$

Since the finesse is the separation over the width of the fringes,

$$\mathscr{F}^{-1} = \left|\frac{\Delta\delta}{\delta}\right| = \left|\frac{\Delta\lambda}{\lambda}\right|$$

(a) $\Delta\lambda = 633\,\text{nm}/312.6 = 2.03\,\text{nm}$

(b) $\Delta\nu = \frac{c}{\lambda^2}\Delta\lambda = 1.52\,\text{kHz}$

4. Given the parameters,

$$N = 92 \text{ fringe pairs}$$
$$\Delta d = 2.53 \times 10^{-5}\,\mathrm{m}$$

The wavelength of the light is determined as

$$\Delta d = N\,(\lambda_0/2)$$
$$\lambda_0 = 550\,\mathrm{nm}$$

5. From the intensity $I = 2I_0(1 + \cos\delta)$, $I_{\max} = 4I_0$. Half intensity would then occur at $2I_0$,

$$2I_0 = 2I_0(1 + \cos\delta)$$
$$0 = \cos\delta$$

This occurs at $\delta = (n + 1/2)\,\pi$. Between adjacent maxima, there is $\pi/2$ difference.

The finesse is the ratio of separation between peaks relative to the full width, i.e.

$$\mathscr{F} = \frac{2\pi}{\pi/2} = 4$$