Answer on Question #49309, Engineering, Other

A diffraction grating is used to resolve two yellow lines 5770 Å and 5790 Å in the 3rd order. If the grating element d is 0.35 mm, calculate the angular location of 3rd order yellow line with respect to the normal. Determine the total width of the ruling/ruled surface.

Solution:

When light is normally incident on the grating, the diffracted light will have maxima at angles θ given by:

$$d \sin\theta = m\lambda$$

Thus,

$$\sin\theta = \frac{m\lambda}{d} = \frac{3 * 5770 * 10^{-10}}{0.35 * 10^{-3}} = 0.0049457.$$

The angular location of 3rd order yellow line

$$\theta = \sin^{-1} 0.0049457 \approx 0.28°$$

The expression for the resolving power for a plane transmission grating is

$$\frac{\lambda}{d\lambda} = mN$$

where $\lambda = 5770$ Å, $\lambda + d\lambda = 5790$ Å, $d\lambda = 20$ Å, $m = 3$

The number of lines

$$N = \frac{\lambda}{md\lambda} = \frac{5770}{3 * 20} = 96 \text{ lines}$$

The total width of the ruling/ruled surface is

$$L = N * d = 96 * 0.35 * 10^{-3} = 0.0336 \text{ m} = 33.6 \text{ mm}$$

Answer: $\theta = 0.28°$, $L = 33.6$ mm.