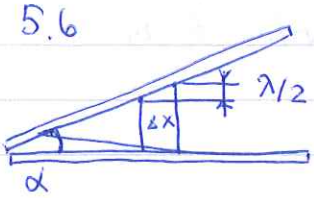
Homework #6 solutions

5.6



The distance in thickness b/w two bright (or dark) lines is $\lambda/2$ (since the reflected beam travels this thickness of the slab twice)

$$\frac{\lambda/2}{\Delta x} = \tan\alpha \approx \alpha \qquad \alpha = \frac{633\cdot10^{-9}\,m}{2\cdot1.5\cdot10^{-2}\,m}$$

$$\alpha = 2.1\cdot10^{-5}\,rad$$

5.7

Optical ~~path~~ in the evacuated tube $= \frac{2\pi}{\lambda}\cdot L$

~~_____~~ " ~~_____~~ the filled tube $= \frac{2\pi n}{\lambda}\cdot L$

Each fringe corresponds to the pass difference of 2π, so m fringes show that the path difference has changed by $m\,(2\pi)$

$$\frac{2\pi n}{\lambda}L - \frac{2\pi}{\lambda}L = \frac{2\pi}{\lambda}(n-1)\cdot L = 2\pi\cdot m$$

$$(n-1) = m\lambda/L$$

6.7

Wavelength in water $\lambda_w = \frac{\lambda_0}{n}$

$$\theta_{max}^{(water)} \approx \frac{m\lambda_w}{d} = \frac{m\lambda_0}{n\cdot d} = \frac{\theta_{max}^{(vacuum)}}{n}$$

The maxima will be closer to each other, by approximately the factor of 1.33.

6.8

The ~~constructive~~ diffraction maxima correspond to the case when all slits contribute radiation in phase, i.e the ~~phase~~ path difference b/w consecutive slits is λ. With additional thickness it is sufficient to achieve the ~~path~~ difference of only $\lambda/2$ to have constructive interference conditions, thus the diffraction maxima will occure ~~where~~ instead of destructive interference, and vice virsa.

Special problem

Assuming the refractive index of the film to be that of water $n = 1.33$

Constructive interference $2nd = \lambda/2$

$\lambda = 4n \cdot d = 4 \cdot 1.33 \cdot 120\,nm \simeq 640\,nm$

red color

Of course, when viewed on a photograph, there will not be a distinct red color, as the conditions for constructive interference for yellow are quite close, so the band will be yellow - orange - red.