General Physics II

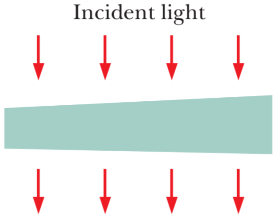
Homework #6

Due 2023/12/13

P6-1. A thin flake of mica ($n = 1.58$) is used to cover one slit of a double-slit interference arrangement. The central point on the viewing screen is now occupied by what had been the seventh bright side fringe ($m = 7$). If $\lambda = 550$ nm, what is the thickness of the mica?

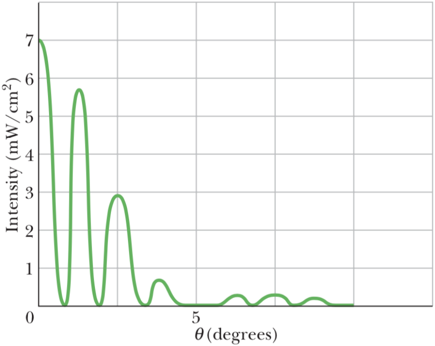
P6-2. Add the quantities $y_1 = 10\sin\omega t$, $y_2 = 15\sin(\omega t + 30^\circ)$, and $y_3 = 5.0\sin(\omega t - 45^\circ)$ using the phasor method.

P6-3. A broad beam of light of wavelength 630 nm is incident at 90° on a thin, wedge-shaped film with index of refraction 1.50. Transmission gives 10 bright and 9 dark fringes along the film's length. What is the left-to-right change in film thickness?



P6-4. (a) Show that the values of α at which intensity maxima for single-slit diffraction occur can be found exactly by differentiating $I(\theta) = I_m \left(\frac{\sin\alpha}{\alpha}\right)^2$ with respect to α and equating the result to zero, obtaining the condition $\tan\alpha = \alpha$. To find values of α satisfying this relation, plot the curve $y = \tan\alpha$ and the straight line $y = \alpha$ and then find their intersections, or use a calculator to find an appropriate value of α by trial and error. Next, from $\alpha = (m + \frac{1}{2})\pi$, determine the values of m associated with the maxima in the single-slit pattern. (These m values are *not* integers because secondary maxima do not lie exactly halfway between minima.) What are the (b) smallest α and (c) associated m, the (d) second smallest α and (e) associated m, and the (f) third smallest α and (g) associated m?

P6-5. Light of wavelength 440 nm passes through a double slit, yielding a diffraction pattern whose graph of intensity I versus angular position θ is shown in figure. Calculate (a) the slit width and (b) the slit separation. (c) Verify the displayed intensities of the $m = 1$ and $m = 2$ interference fringes.



P6-6. Derive this expression for the intensity pattern for a three-slit "grating":

$$I = \frac{1}{9} I_m (1 + 4\cos\phi + 4\cos^2\phi),$$

where $\phi = (2\pi d \sin\theta)/\lambda$ and $a \ll \lambda$.