HW Solution 5

October 4, 2010

35.50

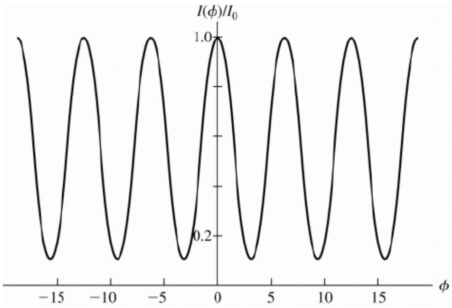
(a) $E_p^2 = E_1^2 + E_2^2 - 2E_1E_2cos(\pi - \phi) = E^2 + 4E^2cos\phi = 5E^2 + 4E^2cos\phi$

$I = \frac{1}{2}\delta_0 cE_p^2 = \delta_0 c[(\frac{5}{2}E^2) + (\frac{4}{2}E^2)cos\phi]$

$\phi = 0 \ \Rightarrow \ I_0 = \frac{9}{2}\delta_0 cE^2$

$\therefore \ I = I_0[\frac{5}{9} + \frac{4}{9}cos\phi]$

(b) The graph is shown in the figure. $I_{min} = \frac{1}{9}I_0$ which occurs when $\phi = n\pi \ (n \ odd)$.



36.53

(a) $I = \frac{1}{2}I_0$ so $\frac{sin\beta/2}{\beta/2} = \frac{1}{\sqrt{2}}$

Let $x = \beta/2$, the equation for x is $\frac{sinx}{x} = \frac{1}{\sqrt{2}} = 0.7017$

$\therefore \ x = 1.39 \ rad, \ \beta = 2.78 \ rad$

$\Delta\theta = 2\theta_+, \ sin\theta_+ = \frac{\lambda\beta}{2\pi a} = 0.4425(\frac{\lambda}{a})$

(i) For $\frac{a}{\lambda} = 2$, $sin\theta_+ = 0.2212, \ \theta_+ = 12.78^o, \ \Delta\theta = 25.6^o$

(ii) For $\frac{a}{\lambda} = 5$, $sin\theta_+ = 0.0885, \ \theta_+ = 5.077^o, \ \Delta\theta = 10.2^o$

(iii) For $\frac{a}{\lambda} = 10$, $sin\theta_+ = 0.04425, \ \theta_+ = 2.536^o, \ \Delta\theta = 5.1^o$

(b)

(i) For $\frac{a}{\lambda} = 2$, $sin\theta_0 = \frac{1}{2}, \ \theta_0 = 30.0^o, \ 2\theta_0 = 60^o$

(ii) For $\frac{a}{\lambda} = 5$, $sin\theta_0 = \frac{1}{5}, \ \theta_0 = 11.54^o, \ 2\theta_0 = 23.1^o$

(iii) For $\frac{a}{\lambda} = 10$, $sin\theta_0 = \frac{1}{10}, \ \theta_0 = 5.74^o, \ 2\theta_0 = 11.5^o$

36.69

(a) $dsin\theta = m\lambda$. Place 1^{st} maximum at ∞ or $\theta = 90^o$. $d = \lambda$. If $d < \lambda$, this puts the first maximum "beyond ∞." Thus, if $d < \lambda$ there is only a single principal maximum.

(b)At a principal maximum when $\delta = 0$, the phase difference due to the path difference between adjacent slits is $\Phi_{path} = 2\pi(\frac{dsin\theta}{\lambda})$. This just scales 2π radians by the fraction the wavelength is of the path difference between adjacent sources. If we add a relative phase δ between sources, we still must maintain a total phase difference of zero to keep our principal maximum.

$$\Phi_{path} \pm = 0 \Rightarrow \frac{2\pi dsin\theta}{\lambda} = \pm\delta \ or \ \theta = sin^{-1}(\frac{\delta\lambda}{2\pi d})$$

(c) $d = 0.02m$. Let $\theta = 45^o$. For $f\lambda = c$,

$$\delta_{max} = \pm \frac{2\pi(0.02m)(8.8 * 10^9 Hz) sin 45^o}{3.00 * 10^8 m/s} = \pm 2.61 rad$$