## DPP 02

**1.** Fringe width, $\beta = \frac{\lambda D}{d}$

D is the distance between the source and screen and d is the slit width.

$15\beta_1 = 10\beta_2$ or $15\lambda_1 = 10\lambda_2$ [$\because$ D and d are kept same ]

or $\lambda_2 = \frac{15}{10} \times 500 = 750$ nm

**2.** Intensity of light at any point on the screen

$I = 4I_0 \cos^2\left(\frac{\phi}{2}\right)$

Phase difference $= \frac{2\pi}{\lambda} \times$ path difference

For $\lambda$ path difference, $\phi_1 = \frac{2\pi}{\lambda} \times \lambda = 2\pi$

$I = 4I_0\cos^2(\pi) = 4I_0 = K$ units

For $\frac{\lambda}{6}$ path difference, $\phi_2 = \frac{2\pi}{\lambda}\left(\frac{\lambda}{6}\right) = \frac{\pi}{3}$

$I = 4I_0\cos^2\left(\frac{\pi/3}{2}\right) = 4I_0\cos^2\left(\frac{\pi}{6}\right) = K(0.75) = \frac{3K}{4} = \frac{9K}{12}$

$\therefore$ n = 9

**3.** $d = 0.15$ mm, $\lambda = 589$ nm, $D = 1.5$ m

As we know the fringe width.

$\therefore\ \beta = \frac{D\lambda}{d} = \frac{1.5 \times 589 \times 10^{-9}}{0.15 \times 10^{-3}} = 5.89 \times 10^{-3}$ m $\approx 5.9$ mm

**4.** $I = I_0\cos^2\left(\frac{\Delta\phi}{2}\right)$; $\Delta\phi = \frac{2\pi}{\lambda} \cdot \Delta x$

Given : $\Delta x = \frac{\lambda}{8}$; $\Delta\phi = \frac{2\pi}{\lambda} \cdot \frac{\lambda}{8} = \frac{\pi}{4}$

So, $I = I_0\cos^2(\pi/8)$; $\frac{I}{I_0} = \cos^2\left(\frac{\pi}{8}\right) = 0.853$

**5.** Intensity of light (I) $\propto$ Width of slit (w).

i.e., $\frac{I_1}{I_2} = \frac{w_1}{w_2} = \frac{4}{1}$

So, $\frac{I_{max}}{I_{min}} = \left(\frac{\sqrt{I_1}+\sqrt{I_2}}{\sqrt{I_1}-\sqrt{I_2}}\right)^2 = \left(\frac{\sqrt{4}+\sqrt{1}}{\sqrt{4}-1}\right)^2 = \frac{9}{1}$

**6.** One fringe is shifted when there is change of $\lambda$ in the path difference of interfering waves. In this case, path difference of $(\mu - 1)t$ is created

So, $(\mu - 1)t = \lambda$ ; $t = \frac{\lambda}{(\mu-1)}$

**7.** $\frac{I_{max}}{I_{min}} = \frac{16}{1}$ or $\left(\frac{A_1+A_2}{A_1-A_2}\right)^2 = \frac{16}{1}$

$\Rightarrow A_1 + A_2 = 4A_1 - 4A_2$

$\Rightarrow 3A_1 = 5A_2$ or $\frac{A_1}{A_2} = \frac{5}{3}$ $\therefore$ $\frac{I_1}{I_2} = \frac{25}{9}$

**8.** $d = 0.320$ mm, $\lambda = 500$ nm

Path difference, $d\sin\theta = n\lambda$

Maximum value of integer,

$$n = \frac{d\sin\theta}{\lambda} = \frac{0.32 \times 10^{-3} \times (1/2)}{500 \times 10^{-9}} = \frac{1600}{5} = 320$$

Hence, total number of maxima observed in angular range $-30^\circ \le \theta \le 30^\circ$ is

$= 320 + 1 + 320 = 641$

**9.** Path difference $= d\sin\theta \simeq d \times \theta$

$$= (0.1\text{ mm})\frac{1}{40} = 2.5 \times 10^{-3}\text{ mm} = 2500\text{ nm}$$

For bright fringes, path difference $= n\lambda$

So, $2500 = n\lambda_1 = m\lambda_2$ or $\lambda_1 = 500$ nm, $\lambda_2 = 625$ nm

**10.** Path difference, $S_2P - S_1P = \lambda/2$

$\sqrt{4d^2 + d^2} - 2d = \frac{\lambda}{2}$

$d(\sqrt{5} - 2) = \frac{\lambda}{2} \Rightarrow d = \frac{\lambda}{2(\sqrt{5}-2)}$

**11.** The phase difference between two waves is given as

$$\Delta x \times \frac{2\pi}{\lambda} = \frac{\lambda}{8} \times \frac{2\pi}{\lambda} = \frac{\pi}{4}$$

So, the intensity at this point is

$$I = I_0\cos^2\frac{\pi}{8}; I = I_0\left(\frac{1+\cos\frac{\pi}{4}}{2}\right);$$

$$I = I_0\left(\frac{1+\frac{1}{\sqrt{2}}}{2}\right) = 0.85I_0$$