Prob-1: Green light of wavelength 5100Å from a narrow slit is incident on a double slit. If the over all separation of 10 fringes on a screen 200 cm away is 2 cm, find the slit separation.

Soln: The fringe width $\beta = \frac{\lambda D}{d}$.

It is given that $D = 200$ cm, $\lambda = 5100 \times 10^{-8}$ cm

and $10\beta = 2$ cm i.e, $\beta = 0.2$ cm.

$\therefore$ The slit separation, $d = \frac{\lambda D}{\beta} = \frac{5100 \times 10^{-8} \times 200}{0.2}$ cm

$$\therefore \boxed{d = 0.05 \text{ cm}}$$

Prob 2: Two coherent sources are 0.18 mm apart and fringes are observed on a screen 80 cm away. It is found that with a certain monochromatic source of light, the fourth bright fringe is situated at a distance of 10.8 ~~cm~~ mm from the central fringe. Calculate the wavelength of light.

Soln: The distance of the n^{th} fringe from the central fringe is $x = \frac{n\lambda D}{d}$

It is given that $D = 80$ cm, $d = 0.18$ mm $= 0.018$ cm

$x = 10.8$ mm $= 1.08$ cm and $n = 4$.

$$\therefore \lambda = \frac{xd}{nD} = \frac{1.08 \times 0.018}{4 \times 80} = 6075 \times 10^{-8} \text{ cm}$$

$$\boxed{\lambda = 6075 \text{ Å}}$$

Prob 3: A light source emits light of two wavelengths 4300Å and 5100Å. The source is used in a double slit experiment. The distance between source and screen is 1.5 m and the distance between the slits is 0.025 mm. Calculate the separation between the third order bright fringes due to these two wavelengths.

Soln: It is given that $\lambda_1 = 4300\,\mathring{A} = 4300 \times 10^{-8}$ cm

$\lambda_2 = 5100\,\mathring{A} = 5100 \times 10^{-8}$ cm, $n = 3$

$D = 1.5$ m $= 150$ cm and $d = 0.025$ mm $= 0.0025$ cm

Now, $x_1 = \dfrac{n\lambda_1 D}{d}$ and $x_2 = \dfrac{n\lambda_2 D}{d}$

$$\therefore x_2 - x_1 = \frac{nD}{d}(\lambda_2 - \lambda_1) = \frac{3 \times 150}{0.0025}(5100 - 4300) \times 10^{-8} \text{ cm}$$

$$\therefore \boxed{x_2 - x_1 = 1.44 \text{ cm} = 1.44 \times 10^{-2} \text{ m}}$$

Prob 4: In a biprism experiment, the eyepiece is placed at a distance of 1.2m from the source. The distance between the virtual sources was found to be 7.5×10^{-4} m. Find the wavelength of light, if the eyepiece is to be moved transversely through a distance of 1.888 cm for 20 fringes.

Soln: The fringe width, $\beta = \dfrac{\lambda D}{d}$ But $\beta = \dfrac{l}{n}$

$$\therefore \lambda = \frac{ld}{nD}$$

It is given that $l = 1.888$ cm $= 0.01888$ m,

$d = 7.5 \times 10^{-4}$ m, $n = 20$ and $D = 1.2$m.

$$\therefore \lambda = \frac{0.01888 \times 7.5 \times 10^{-4}}{20 \times 1.2} = 5900 \times 10^{-10} \text{ m}$$

$$\boxed{\lambda = 5900 \times 10^{-10} \text{ m} = 5900\,\mathring{A}}$$

Prob 5: A thin sheet of transparent material ($\mu = 1.60$) is placed in the path of one of the interfering beams in a biprism experiment using sodium light, $\lambda = 5890\,\mathring{A}$. The central fringe shifts to a position originally occupied by 12^{th} bright fringe. Calculate the thickness of the sheet.

Soln: The thickness of the sheet, $t = \frac{n\lambda}{\mu - 1}$

It is given that $\mu = 1.60$, $n = 12$, $\lambda = 5890\,Å$

$$t = \frac{12 \times 5890 \times 10^{-10}}{1.60 - 1}\ m = 1.18 \times 10^{-5}\ m$$

$$\therefore \boxed{t = 1.18 \times 10^{-5}\ m = 0.118\ \mu m}$$

Prob 6: In Lloyd's single mirror interference experiment, the slit source is at a distance of 2 mm from the plane of the mirror. The screen is kept at a distance of 1.5 from the source. Calculate the fringe width. Wavelength of light is 5890 Å.

Soln: The fringe width $\beta = \frac{\lambda D}{d}$

It is given that $\lambda = 5890\,Å = 5890 \times 10^{-10}\ m$,

$D = 1.5\ m$ and $d/2 = 2\ mm$

$d = 4 \times 10^{-3}\ m$

$$\beta = \frac{5890 \times 10^{-10} \times 1.5}{4 \times 10^{-3}}\ m$$

$$\therefore \boxed{\beta = 22 \times 10^{-3}\ m = 22\ mm}$$

Prob 7: A glass wedge of angle 0.01 radian is illuminated by monochromatic light of wavelength 6000 Å falling normally on it. At what distance from the edge of the wedge will ~~be~~ the 10th fringe be observed with reflected light?

Soln: Given that, $\theta = 0.01\ rad$, $m = 10$, $\lambda = 6000 \times 10^{-8}\ cm$

The condition for forming dark fringe is, $2t = m\lambda$

The angle of the wedge, $\theta = \frac{t}{x}$ or, $t = \theta x$

$$\therefore 2\theta x = m\lambda$$

$$\therefore x = \frac{m\lambda}{2\theta} = \frac{10 \times 6000 \times 10^{-8}}{2 \times 0.01}\ cm$$

$$\therefore \boxed{x = 3\ mm}$$

Prob. 8: A beam of monochromatic light of wavelength 5.82×10^{-7} m falls normally on a glass wedge with the wedge angle of 20 seconds of an arc. If the refractive index of glass is 1.5. Find the number of dark fringes per cm of the wedge length.

Soln: Given wedge angle $\theta = 20'' = \frac{20\times\pi}{60\times60\times180}$ radians

$\lambda = 5.82\times10^{-7}$ m, $\mu = 1.5$

Fringe width $\beta = \frac{\lambda}{2\mu\theta} = \frac{5.82\times10^{-7}\times60\times60\times180}{2\times1.5\times20\times\pi}$ m

$= 2$ mm

Number of fringes per cm $= \frac{1}{0.2 \text{ cm}} = 5$ per cm

Prob 9: Newton's rings are observed in reflected light of $\lambda = 5.9\times10^{-5}$ cm. The diameter of the 10^{th} dark ring is 0.5 cm. Find the radius of curvature of the lens and the thickness of the air film.

Soln: Given that $\lambda = 5.9\times10^{-5}$ cm, $m = 10$

The radius of m^{th} dark ring is, $R = \frac{r^2}{m\lambda} = \frac{(0.5)^2}{10\times5.9\times10^{-5}}$ cm

$\therefore \boxed{R = 106 \text{ cm} = 1.06 \text{ m}}$

The thickness of the film is given by

$t = \frac{m\lambda}{2} = \frac{10\times5.9\times10^{-5}}{2}$ cm

$\therefore \boxed{t = 2.95\ \mu m}$

Prob 10: In a Newton's rings experiment, the diameter of 15^{th} and 5^{th} ring ~~was~~ were 0.59 cm and 0.336 cm. If the radius of the plano-convex lens ~~is~~ was 100 cm, Calculate the wavelength of the light used.

Soln: We know, $\lambda = \frac{D_{m+p}^2 - D_m^2}{4pR} = \frac{D_{15}^2 - D_5^2}{4\times10\times R} = \frac{(5.9)^2-(3.36)^2}{4\times10\times1}\times10^{-6}$ m

$\therefore \boxed{\lambda = 5880\times10^{-10} \text{ m} = 5880\ \text{Å}}$

From :- Arpita Bose, 25/3/20
Dept. of Physics, Asutosh College