ENGINEERING PHYSICS A (PHT 100)

MODULE: 2 CHAPTER: 1

INTERFERENCE

(Numerical Problems)

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1 A soap film of refractive index 4/3 and of thickness 1.5×10^{-4}cm is illuminated by white light incident at an angle of 60^0. The light reflected by it is examined by a spectroscope in which it is found a dark band corresponding to a wavelength of 5×10^{-5}cm. Calculate the order of interference of the dark band.

The condition for dark band in thin film interference of reflected light

$2\mu t\cos r = n\lambda$, where $n = 1,2,3...$

$$\mu = \frac{\sin i}{\sin r}$$

$\mu = 4/3$

$i = 60^0$

$t = 1.5\times10^{-4}$ cm

$\lambda = 5\times10^{-5}$ cm

$n = ?$

Order of the dark band n = 6 (6.08)

2 A parallel beam of light ($\lambda = 5890\times10^{-8}$cm) is incident on a thin glass plate (μ=1.5) such that the angle of refraction into the plate is 60^0. Calculate the smallest thickness of the glass plate which will appear dark by reflection.

The condition for dark band in thin film interference of reflected light

$2\mu t\cos r = n\lambda$, where $n = 1,2,3...$

$\mu = 1.5$

$r = 60^0$

$\lambda = 5890\times10^{-8}$ cm

$n = 1$

$t_{min} = ?$

$t_{min} = 3.927\times10^{-7}$ m.

3 A beam of parallel rays is incident at an angle of 30^0 with the normal on a plane parallel film of thickness 4×10^{-5}cm and refractive index 1.5. Show that the reflected light whose wavelength 7.539×10^{-5}cm will be strengthened by reinforcement.

The condition for bright band in thin film interference of reflected light

$$2\mu t\cos r = (2n+1)\frac{\lambda}{2} \quad (n = 0,1,2,3....)$$

i.e. $2\mu t\cos r$ Should be an odd multiple of $\frac{\lambda}{2}$.

$$\mu = \frac{\sin i}{\sin r}$$

$\mu = 1.5$

$i = 30^0$

$t = 4\times10^{-5}$ cm

$\lambda = 7.539\times10^{-5}$ cm

$r = ?$

$(2n+1) = ?$

2n+1 =3 (3.001)

4 A thin layer has a refractive index 1.334. Find the minimum thickness for zero reflection when light of wavelength $6000A^0$ is incident normally.

The condition for dark band in thin film interference of reflected light

$2\mu t\cos r = n\lambda$, where $n = 1,2,3...$

$\mu = 1.334$

$i = 0;\ r = 0$

$\lambda = 6000 \times 10^{-10}\,m$

$n = 1$

$t_{min} = ?$

$t_{min} = 2249A^0$

5 In an air wedge setup a wire of diameter 0.05mm is placed at a distance of 0.15m from the line of contact of the glass plates. Calculate the fringe width if monochromatic light of wavelength $6000A^0$ falls normally on the wedge.

$$\theta = \frac{\lambda}{2\beta} \text{ and } \theta = \frac{d}{L} \quad \text{or} \quad \frac{d}{L} = \frac{\lambda}{2\beta}$$

$$\beta = \frac{\lambda L}{2d}$$

$d = 0.05\text{mm}$

$L = 0.15\text{m}$

$\lambda = 6000 \times 10^{-10}\text{m}$

$\beta = ?$

$$\beta = 9 \times 10^{-4}\text{m}$$

6 In Newton's rings experiment the diameters of the 4^{th} and 12^{th} dark rings are 0.4cm and 0.7 cm respectively. Find the diameter of the 20^{th} dark ring.

$$\lambda = \frac{D_{n+k}^{\ 2} - D_n^{\ 2}}{4Rk} \text{ or } D_{n+k}^{\ 2} - D_n^{\ 2} = 4Rk\lambda$$

$$D_{12}^{\ 2} - D_4^{\ 2} = 4R \times 8 \times \lambda - - - (1)$$

$$D_{20}^{\ 2} - D_{12}^{\ 2} = 4R \times 8 \times \lambda - - - (2)$$

$$D_{12}^{\ 2} - D_4^{\ 2} = D_{20}^{\ 2} - D_{12}^{\ 2}$$

$$D_{20} = 0.906\,\text{cm}$$

$$D_4 = 0.4\,\text{cm}$$
$$D_{12} = 0.7\,\text{cm}$$
$$D_{20} = ?$$

7 An air wedge is formed with two glass plates (each of length 5cm) and a thin wire at one of the ends. The wavelength of light used is 589nm. If 200 fringes are formed, find the radius of the wire.

$$\theta = \frac{\lambda}{2\beta} \text{ and } \theta = \frac{d}{L} \quad \text{or} \quad \frac{d}{L} = \frac{\lambda}{2\beta}$$

$$d = 2r = \frac{\lambda L}{2\beta} \quad \text{or} \quad r = \frac{\lambda L}{4\beta}$$

$$L = 5\text{cm}$$
$$N = 200$$
$$\lambda = 589\text{nm}$$

$$\beta = \frac{5\times10^{-2}}{200}$$

$$r = 2.945\times10^{-5}\,\text{m}$$

8 Newton's rings are observed using reflected light of wavelength $5900A^0$. Find the radius of curvature of the lens and the thickness of the air film at the position of the 10^{th} dark ring whose diameter is 0.5cm.

$$D_n^{\,2} = 4Rn\lambda$$

$$2t = n\lambda$$

$D_{10} = 0.5\text{cm}$

$\lambda = 5900\ A^0$

$R = ?$

$t_{10} = ?$

$R = 1.059\,\text{m}$ $\qquad$ $t = 2.95\times10^{-6}\,\text{m}$

9 In a Newton's rings experiment , the diameter of 5^{th} ring and 15^{th} ring are 0.4cm and 0.6cm respectively. If the radius of curvature of the plano-convex lens is 1m, find the wavelength of light used.

$$\lambda = \frac{D_{n+k}^{\ 2} - D_n^{\ 2}}{4Rk}$$

$D_5 = 0.4\text{cm}$

$D_{15} = 0.6\,\text{cm}$

$R = 1\,\text{m}$

$\lambda = ?$

$\lambda = 5\times10^{-7}\,\text{m}$

10 Calculate the angle of the air wedge in radians to form uniform fringes of thickness 0.01cm for monochromatic light of wavelength $6000A^0$.

$$\theta = \frac{\lambda}{2\beta}$$

$$\beta = 0.01\text{cm}$$

$$\lambda = 6000\,A^0$$

$$r = 3\times10^{-3}\,\text{rad}$$

THANK YOU