(4) White light falls normally on the soap film ($\mu = 1.33$) of thickness 3800 Å. Which wavelength/s within the visible spectrum (4000 Å − 7000 Å) will be intensified in the reflected light?

rarer − denser − rarer

$\mu = 1.33$, $t = 3800\ \text{Å} = 3.8 \times 10^{-7}\ m$

→ satisfy condn of max in reflected system.

for reflected system

$$\delta = 2\mu t \cos r + \frac{\lambda}{2} \rightarrow (1)$$

for max,

$$\delta = n\lambda \longrightarrow (2)$$

∴ from (1) & (2)

$$2\mu t \cos r = (2n-1)\frac{\lambda}{2}$$

$$\therefore \lambda = \frac{4\mu t \cos r}{(2n-1)} \quad \because r = 0, \cos r = 1$$

$$\lambda = \frac{4\mu t}{(2n-1)} \longrightarrow (3)$$

for $n=1 \Rightarrow \lambda = 20.216 \times 10^{-7}\ m = 20126\ \text{Å}$ (not visible)

$n=2, \Rightarrow \lambda = 6.738 \times 10^{-7} = 6738\ \text{Å}$ (visible)

$n=3 \Rightarrow \lambda = 4.043 \times 10^{-7} = 4043\ \text{Å}$ (visible)

$n=4 \Rightarrow \lambda = 2.888 \times 10^{-7}\ m = 2888\ \text{Å}$ (not visible)

(5) A parallel beam of light falls normally on an oil film of RI 1.25. Complete destructive interference is observed for wavelengths 5000 Å and 6000 Å and for no wavelength in between. Find the thickness of the oil.

rarer - denser - rarer, $\mu = 1.25$,

$\lambda_1 = 5000\,\text{Å} = 5 \times 10^{-7}\,m$, $\lambda_2 = 6000\,\text{Å}$

$\lambda_2 = 6 \times 10^{-7}\,m$

succ. order of minima.

ie if one $\rightarrow n$

other $\rightarrow (n+1)$ or $(n-1)$

reflected system, $\delta = 2\mu t \cos r + \frac{\lambda}{2} \rightarrow (1)$

for min., $\delta = (2n+1)\frac{\lambda}{2} \rightarrow (2)$

from (1) and (2) $2\mu t \cos r = n\lambda \rightarrow (3)$

$\lambda_1 > \lambda_2 \quad \therefore \lambda_1 \rightarrow$ higher order $\rightarrow (n+1)$

$\lambda_2 \rightarrow$ lowerst order $\rightarrow (n)$

$\therefore$ for λ_1 and λ_2

$2\mu t \cos r = n\lambda_2 \rightarrow (4)$

$2\mu t \cos r = (n+1)\lambda_2 \rightarrow (5)$

solve

$n\lambda_2 = (n+1)\lambda_2$

$\Rightarrow \boxed{n = 5}$

$\therefore r = 0, \cos r = 1$

from (4) $2\mu t = n\lambda_2$

$$t = \frac{n\lambda_2}{2\mu} = \frac{5 \times 6 \times 10^{-7}}{2 \times 1.25} = 12 \times 10^{-7}\,m$$

$t = 12000\,\text{Å}$

⑥ A soap film of RI 1.33 and thickness 1.5 μm is illuminated by white light incident at an angle of 45°. In the reflected light a dark band is observed for the wavelength 5×10^{-5} cm. Calculate the order of the interference band.

rarer - denser - rarer

$\mu = 1.33,\ t = 1.5 \times 10^{-6}\ m,\ i = 45^\circ$

dark, $\lambda = 5 \times 10^{-7}\ m,\ n = ?$

for reflected $\delta = 2\mu t \cos r + \frac{\lambda}{2} \rightarrow (1)$

for dark $\delta = (2n+1)\frac{\lambda}{2} \rightarrow (2)$

$\therefore$ from (1) and (2)

$$2\mu t \cos r = n\lambda$$

$$\therefore n = \frac{2\mu t \cos r}{\lambda} \rightarrow (3)$$

$$\mu = \frac{\sin i}{\sin r} \Rightarrow \sin r = \frac{\sin i}{\mu} = \frac{\sin 45^\circ}{1.33} = 0.5316$$

$$r = 32.11^\circ \Rightarrow \boxed{\cos r = 0.8469}$$

from (3) $$n = \frac{2 \times 1.33 \times 1.5 \times 10^{-6} \times 0.8469}{5 \times 10^{-7}}$$

$$n = 6.75$$

$\therefore$ max. order is 6