<u>Numerical Problems on Interference and Diffraction</u>

1. A parallel beam of light of wavelength 5890 Å is incident on a glass plate having refractive index μ = 1.5 such that the angle of refraction in the plate is 60^0. Calculate the smallest thickness of glass plate for which it will appear dark in reflected light.

Formula: $2\mu t cos r = n\lambda$ **[Ans. smallest thickness, t_{min} = 0.3926 μm]**

2. Light beam of wavelength 6000 Å falls normally on a thin wedge shaped film of refractive index 1.4, forming fringes that are 2 mm apart. Find the angle of the wedge.

Formula: $\lambda = 2\,\theta\,\mu\beta$ **[Ans.** $\theta = 1.07 \times 10^{-4}$ **radian]**

3. A drop of liquid of volume 0.2 cc is dropped on a surface of a tank of water of area 1 sq. meter. The film spreads uniformly over the whole surface and white light which is incident normally, is observed through a spectrometer. The spectrum is seen to contain one dark band whose centre has wavelength 5.5×10^{-5} cm in air. Find the refractive index of oil.

Formula: $2\mu t cos r = n\lambda$**, find t using area and volume** **[Ans. μ =1.375]**

4. In Newton's ring arrangement, if a drop of water having refractive index 1.33 is placed between the lens and the plate, the diameter of the 10^{th} ring is found to be 6×10^{-3} m. Obtain the radius of curvature of the face of lens in contact with the plate. The wavelength of light used is 600 nm.

Formula: $D_n^2 = \frac{4n\lambda R}{\mu}$ **[Ans.: R = 2m]**

5. Newton's rings are formed by light reflected normally from convex lens of radius of curvature of 90 cm and a glass plate with liquid in between them. The diameter of n^{th} dark ring is 2.25 mm and that of $(n + 9)^{th}$ dark ring is 4.5 mm. Calculate the refractive index of the liquid. Given λ = 6000 Å.

Formula: $R = \frac{(D_{n+m}^2 - D_n^2)\mu}{4m\lambda}$ **[Ans: Refractive index of liquid μ = 1.28]**

6. In a Newton's ring experiment, the diameter of the 4^{th} and 12^{th} dark rings are 0.400 cm and 0.700 cm respectively. Determine the diameter of 20^{th} dark ring.

[Ans. d_{20} = 0.895 cm]

7. In a single slit Fraunhofer diffraction experiment using monochromatic light of 589.3 nm wavelength and a slit width of 6 μm, calculate the angular separation between first order minima on either side of central maximum.

Formula: $d\sin\theta = n\lambda$ **[Ans.: angular separation θ = 5.63deg]**

8. A light of 500 nm wavelength is incident normally on a single slit. The first minimum of Fraunhofer diffraction pattern is observed to lie at a distance of 5 x $10^{(-3)}$ m from the central maximum on a screen placed at a distance of 2 m away from the slit. What is the width of the slit?

Formula: $d\sin\theta = n\lambda$ **[Ans.: slit width, a = 50μm]**

9. Monochromatic light of $\lambda = 6560A^0$ falls normally on the grating 2 cm wide. The first order spectrum is produced at an angle 19^0 from the normal. What is the total number of lines on the grating?

Formula: $d\sin\theta = n\lambda$, $d=1/N$, N= no. of lines/cm ruled on the grating

[Ans.: Number of lines on grating, N = 9925 per 2 cm]

10. A grating has 10 cm of the surface ruled with 6000 lines / cm. what is the resolving power of the grating in the first order?

Formula: R.P = R = mN. **[Ans: 6×10^4]**

11. 15. Light beam from a sodium lamp (λ = 5893 A0) is a doublet of 6 A0. Calculate the minimum number of lines needed on the grating to resolve the doublet in the third order.

[Ans. In III order N = 327]