COLLEGE OF ENGINEERING ROORKEE, ROORKEE
Autumn Semester 2014-2015

Subject: Physics **Subject Code: TPH101**
Interference **Tutorial Sheet: 1**

Numerical Problems:

1. In an interference pattern, the intensity variation is found to be 4% of the average intensity. Calculate the relative intensities of the interfering sources. Ans.2502:1

2. The inclined faces of a biprism of glass (μ= 1.5) make angles of 0.5^o with its base. The slit is at 20cm from the biprism and is illuminated by sodium light of wavelength 589 nm. Find the fringe width on a screen placed at 1.2m from the biprism. Ans. 0.04725cm

3. The distance between the slit and the biprism and that between the biprism and the screen are 25cm and 75cm, respectively. The obtuse angle of the biprism is 178^o and refractive index 1.55. Evaluate the distance between the virtual sources formed by the biprism. If the fringe width is 0.0125cm calculate the wavelength of light. Ans. 4.8mm, 6000A

4. A monochromatic light of wavelength 500nm is incident on two slits separated by a distance of 0.75mm. The interference pattern is seen on a screen placed at a distance 1.5m away from the slits. A thin glass plate of thickness 2.5μm and refractive index 1.5 is placed between one of the slits and the screen. Find the intensity at the centre of the screen. Also calculate the lateral shift of central maximum. Ans. Zero, 2.5mm

5. Interference fringes are formed by the superposition of two beams of wavelength 600nm. If a thin plate of material with t=0.001cm is placed in the path of one of the beams, the central fringe shifts to a place occupied by 10th fringe. Find the refractive index of the material of the plate. Ans. 1.6

6. In a double slit arrangement, fringes are produced by using light of wavelength 4800 A. one slit is covered by a thin sheet of glass of refractive index 1.48 and thickness $6x10^{-4}$cm and the other slit by a thin mica sheet of refractive index 1.6 so that the central fringe shifts to a position previously occupied by the 5th bright fringe from the centre. Find the thickness of the mica sheet. Ans. $8x10^{-4}$cm

7. A parallel beam of light of wavelength 5890A is incident on a thin glass plate with refractive index 1.5 such that the angle of refraction into the plate is 45^o. Calculate the minimum thickness of the plate for which it will appear dark in reflected light. Ans.2776.57 A

8. White light falls normally upon a soap film of thickness $5x10^{-5}$cm and refractive index 1.33. What wavelength in the visible region will be reflected more strongly? Ans. 5320A

9. An oil film (μ = 1.47) and thickness 0.24μm rests on water. If a monochromatic light strikes the film at an angle 60^o, what is the wavelength of light. Ans. 570nm

10. White light is incident on a soap film at an angle 40^o and the reflected light is examined by a spectroscope. This showed two consecutive dark bands corresponding to 610nm and 600nm, respectively. If the refractive index of the film is 4/3, calculate the thickness of the film. Ans. $6.38x10^{-3}$cm

11. Light of wavelength 600 nm falls normally on a thin wedge shaped film of refractive index 1.35, forming fringes 1mm apart. Find the angle of wedge in degrees. Ans. 0.0127^o

12. If the angle of the wedge is 0.3^o and the wavelengths of sodium D lines are 589 and 589.6 nm, find the distance of the apex of the wedge at which the maximum due to the two wavelengths first coincide. Ans. 5.53cm

13. Newton's rings are observed normally in the reflected light of wavelength 590 nm. The diameter of the tenth bright ring is 0.5cm. Find the radius of curvature of the plano-convex lens and the thickness of the film at that point.
Ans.111.5 cm, $2.8 x 10^{-4}$cm

14. A Newton's ring arrangement is used with a source emitting two wavelengths (λ_1=600nm and λ_2= 540nm) and it is found that the nth dark ring of λ_1 coincides with $(n+1)^{th}$ dark ring of λ_2. If the radius of curvature of the lens is 90cm find the diameter of $(n+5)^{th}$ bright ring for λ_1. Ans. 0.54cm

15. In Newton's ring experiment the diameter of 16^{th} bright ring changes from 1.8 cm to 1.5cm when a liquid is introduced the plate and the lens. Find the refractive index of the liquid and the diameter of the 5^{th} dark ring.
Ans. 1.44, 1.045cm

16. Newton's rings are produced by using a plano-convex lens of radius of curvature 2m and diameter 3cm. How many rings are observed if water is used between the lens and the plate? Take λ=6000A and the refractive index of water to be 1.33.
Ans. 250

17. Newton's rings are obtained with light of wavelength 5577A and a thin layer of oil (refractive index 1.55) formed between planoconvex lens (radius of curvature 1m and refractive index 1.6) and glass plate (refractive index 1.5). Calculate the radius of the smallest dark ring. Ans. 0.0424cm

18. If the convex surface of a plano convex lens of radius of curvature 1.2m is placed on a concave surface of radius of curvature 2m, Newton's rings are formed in the reflected system with the light of wave length 660nm.calculate the diameter of 10^{th} dark ring. Ans. $8.9 x 10^{-3}$ m

19. In Young double slit experiment the slits are 0.5mm apart and interference is observed on a screen placed at a distance of 100cm from the slits. It is found that the 9tn bright fringe is at a distance of 8.835mm from the second dark fringe from the centre of the fringe pattern. Find the wavelength of light used. Ans 5890A

20. A double slit of separation 1.5mm is illuminated by white light (between 4000-8000A). On a screen 120cm away colored interference pattern is formed. If a pinhole is made on this screen at a distance of 3mm from the central white light, what wavelengths will be absent in the transmitted light? Ans 6800,5800,5500,4400,4000A

21. Magnesium fluoride has a refractive index of 1.38 and is frequently used to coat lenses. How thick this coating should be for maximum transmitted light at a wavelength of 5.30nm? Ans $0.9601 x 10^{-5}$cm

22. In a modified Young double slit experiment, a monochromatic uniform and parallel beam of light of the wavelength 6000A and intensity($10/\pi$) W/m^2 is incident normally on two circular apertures A and B of radii 0.001m and 0.002m respectively. A perfect transparent film of thickness 2000A and refractive index 1.5 for wavelength of 6000A is placed infront of aperture A. Calculate the power (in watts) received at the focal spot of the lens. The lens is symmetrically placed with respect to the aperture. Assume that 10% of the power received by each aperture goes in the original direction and is brought to the focal spot. Ans $7 x 10^{-6}$watt

23. In a biprism experiment with sodium light, bands of width 0.0195cm are observed at 100cm from the slit. On introducing a convex lens 30cm away from the slit, two images of the slit are seen 0.7cm apart, at 100cm distance from the slit. Calculate the wavelength of sodium light. Ans 5850A

24. White light falls normally on a film of soapy water whose thickness is $5 x 10^{-5}$cm and μ = 1.33. Which wavelength in the visible region will be reflected most strongly. Ans 5230A

25. A parallel beam of sodium light strike a film of oil (μ = 1.46) floating on water (μ = 1.33). When viewed at an angle of 30 from the normal, the eight dark band is seen, Find the thickness of the film. Ans $1.7 x 10^{-4}$cm

26. A film of refractive index μ is illuminated by white light at an angle of incidence i. In reflected light two consecutive fringe of wave length λ_1 and λ_2 are found overlapping. Obtain an expression for the thickness of the film.

27. A drop of oil of volume 0.2 cm^3 is dropped on the surface of a tank of water of area $1m^2$. The film spreads uniformly over the whole surface and white light reflected normally is observed through a spectrometer. The separation is seen to contain first dark band whose centre has wavelength of 5.5×10^{-7}m. Find the refractive index of oil. Ans 1.375

Theoretical Questions:

1. What is interference? State and explain the conditions for obtaining good interference fringes.

2. What are coherent sources? How are they realized in practice?

3. Explain the formation of interference fringes by means of Fresnel's biprism using a monochromatic source. Describe the method for determination of wavelength of light using biprism.

4. What are Newton's rings? Show that the diameters of bright rings are proportional to square root of odd natural numbers and that the separation between rings decreases as the order increases.

5. Describe the method for determination of refractive index of a liquid using Newton's ring experiment and derive the necessary expression.

6. What happens when the monochromatic source is replaced by a white light source in (i) Newton's ring experiment, (ii) biprism experiment?

7. Why the center of the Newton's rings appears dark? Can we get a bright central fringe? If yes, how?

8. Differentiate between the fringes formed by Newton's ring experiment and that in the biprism experiment.

9. Explain the effect of introducing a thin transparent plate in the path of one of the beams in the biprism experiment. How it is used to find out the refractive index of the material of the sheet or its thickness?

10. How will you locate the zero order fringe in the biprism experiment?

11. Show that the diameter D_n of the n^{th} Newton's ring, when two convex surfaces of radii R_1 and R_2 are placed in contact, is given by $1/R_1 + 1/R_2 = 4n\lambda / D_n^2$,where λ is the wavelength of light used.