Unit I Wave optics Questions

1. List out the necessary conditions for obtaining interference fringes? [L1]
2. Explain the interference from thin parallel films due to reflected light. Deduce the condition for bright and dark bands. [L3]
3. Illustrate the formation of Newton's rings in reflected system. Obtain an expression for radius of curvature of the plano convex lens. [L3]
4. Discuss the theory of Newton's rings with relevant diagram, hence estimate the diameter of dark and bright rings. [L3]
5. Distinguish interference and diffraction. [L1]
6. Distinguish Fresnel and Fraunhoffer diffraction. [L1]
7. Discuss diffraction due to single slit. Estimate the width of central maximum. [L3]
8. Demonstrate diffraction due to double slit. [L2]
9. Illustrate the working principle of a diffraction grating. [L2]
10. Define resolving power of a grating and deduce the expression for it. [L3]
11. Differentiate polarized and unpolarized light. [L1]
12. List different types of polarized light. [L1]
13. State and Explain Brewster's law. [L2]

    Or
14. Show that the reflected and refracted rays are perpendicular to each other when the light ray incident at Brewster's angle or at angle of polarization. [L2]

    Or
15. Illustrate the technique to produce the polarized light by reflection. [L2]
16. Demonstrate double refraction. [L2]
17. Illustrate the construction and working of Nocol's prism. [L2]
18. Discuss the construction and working of quarter wave plate and half plates. [L2]

Short answer questions

1. Define interference.
2. Illustrate the principle in the formation of colors in thin films in the reflected region.
3. Demonstrate the principle in the formation of Newton's rings.
4. Why the Newton's rings are circular in nature.
5. Why the central ring is dark in Newton's rings experiment.
6. List the conditions for interference.
7. Quote principle of superposition.
8. Explain the effect on the Newton's rings if a litter water is introduced in between the plano convex lens and plane glass plate.
9. Demonstrate the Newton's rings with white light.
10. Define monochromatic source of light.
11. Define diffraction.
12. Enumerate the conditions for diffraction.
13. State Fresnel diffraction.
14. Define Fraunhoffer diffraction.
15. If the width of the slit increases in single slit, then explain diffraction pattern on the screen.
16. List the conditions for central maximum, secondary maxima and minima in diffraction due to a single slit.
17. Explain the diffraction pattern observed on the screen due to double slit.
18. Define grating. Explain its working principle.
19. Define dispersive power and resolving powers of grating.
20. Write the expression for resolving power of grating.
21. Tell for which colors the angle of diffraction is minimum and maximum when white light is used in the formation of spectrum using diffraction grating.
22. Define plane polarized light, partially polarized light, circularly polarized light and elliptically polarized light.
23. State Brewster's law.
24. Demonstrate a simple technique to produce plane polarized light.
25. Elucidate double refraction.
26. What are the applications of Nicol prism.

27. What is a quarter wave plate ?
28. What is a half wave plate ?
29. If the angle of polarization is 60^o. What are the angles of reflection and refraction?
30. If the angle of polarization is 60^o. What is the refractive index of the medium?

Quiz questions

1	**Two sources are said to be coherent if their emitted waves have** **(A) Same wavelength (B) Same amplitude (C) Same phase (D) All the above**	**[D]**
2	**Color of thin films is due to ----Interference---**	
3	**The condition for minima in thin films** **(A) 2µtcosr=nλ (B) 2µtcosr=(2n+1)λ/2 (C) 2µtcosr=nλ/2 (D) 2µtsinr=nλ**	**[A]**
4	**When a light ray is reflected from the surface of denser medium it experiences a path difference of ----- λ/2---------**	
5	**Working principle of grating is** **(A) interference (B) diffraction (C) polarization (D) dispersion**	**[B]**
6	**In Fraunhoffer diffraction the wave front undergoing diffraction is** **(A) spherical (B) cylindrical (C) elliptical (D) plane**	**[D]**
7	**Expression for resolving power of grating is ---- λ/dλ=nN--------**	
8	**A grating has 4000 lines/cm. The maximum number of orders possible with this grating when monochromatic light of wavelength 5000 A is used** **(A) 4 (B) 5 (C) 6 (D) 8**	**[B]**
9	**The angle of polarization for a medium is 60^o, then the refractive index of the medium is ----1.732-------**	
10	**In a doubly refracting crystal, along the optic axis** **(A) $\mu_o > \mu_e$ (B) $\mu_o < \mu_e$ (C) $\mu_o = \mu_e$ (D) $2\mu_o > 3\mu_e$**	**[C]**
11	**The best example of monochromatic light source is** **(A) bulb (B) candle (C) LASER (D) Soudium vapour lamp**	**[D]**
12	**The example of doubly refracting crystal is** **(A) Nacl (B) KCl (C) $MgCl_2$ (D) Quartz**	**[D]**
13	**The wavelength of light emitted by sodium vapor lamp is ------5893 A----**	
14	**The example of positive crystal is** **(A) Quartz (B) Caclicite (C) NaCl (D) KCl**	**[A]**
15	**According to Brester's law the reflected and refracted light rays are** **(A) Parallel (B) perpendicular (C) opposite (D) all the**	**[B]**
16	**The example of negative crystal is** **(A) Quartz (B) Caclicite (C) NaCl (D) KCl**	**[B]**
17	**The path difference introduced by a half wave plate between e-ray and o-ray is** **(A) λ/2 (B) λ/4 (C) λ/3 (D) λ/5**	**[A]**
18	**The path difference introduced by a quarter wave plate between e-ray and o-ray is** **(A) λ/2 (B) λ/4 (C) λ/3 (D) λ/5**	**[B]**

19 With an increase in order the diameter of Newtons rings. [A]

(A) increases (B) decreases (C) Remains same (D) None of the above

20 When a transparent liquid is introduced between plano convex lens and plane glass plate the diameter of rings [A]

(A) increases (B) decreases (C) Remains same (D) All the above

Unit I INTERFERENCE IN THIN FILMS

1. A soap film of refractive index 1.33 and thickness 5000 A is exposed to white light. What wavelengths in the visible region are reflected?
   Answer: 5320 A is the wavelength in the visible region.

2. A soap film of refractive index 4/3 and of thickness $1.5X10^{-4}$ cm is illuminated by white light incident at an angle of 60^o. The light reflected by it is examined by a spectroscope in which it is found a dark band corresponding to wavelength of $5X10^{-5}$ cm. Estimate the order of interference of the dark band.
   Answer: 6

3. A parallel beam of light λ=5890 A, is incident on a glass plate μ=1.5 such that angle of refraction into plate is 60^o. Calculate the smallest thickness of the plate which will make it appear dark by reflection.
   Answer: 3927 A

NEWTON'S RINGS

1. Calculate the thickness of air film at 10^{th} dark ring in a Newton's rings system viewed normally by a reflected light of wavelength 500 nm. The diameter of the 10^{th} dark ring is 2 mm.
   Answer: The thickness of the air film corresponding to 10^{th} dark ring = 2.5 μm.

2. In a Newton's rings experiment the diameter of 15^{th} ring was found to be 0.59 cm and that of 5^{th} ring is 0.336 cm. If the radius of curvature of lens is 100 cm. Find the wavelength of the light.
   Answer: Wavelength of the light =588 nm.

3. Newton's rings are observed in the reflected light of wavelength 5900 Å. The diameter of tenth dark ring is 0.5 cm. Find the radius of curvature of the lens used.
   Answer: The radius of curvature of the lens =1.059 m.

4. Newton's rings are formed with reflected light of wavelength $5.895X10^{-5}$ cm with a liquid between the plane and the curved surface. The diameter of the 5^{th} dark ring is

0.3cm and the radius of curvature of the curved surface is 100 cm. Compute the refractive index of the liquid.

Answer: The refractive index of the liquid is =1.31

5. In a Newton's ring experiment the diameter of the 10^{th} ring changes from 1.40 cm to 1.27 cm when a liquid is introduced between the lens and the plate. Evaluate the refractive index of the liquid.

Answer: The refractive index of the liquid μ=1.215

Diffraction

1. A slit of width 1.5 mm is illuminated by a light of wavelength 500 nm and diffraction pattern is observed on a screen 2 m away. Determine the width of the central maximum.

Answer: Width of the central maximum 2x = 1.33 mm.

2. A screen is placed 2 m away from a narrow slit. Find the slit width if the first minimum lies at 5 mm on either side of the central maximum when plane waves of 500 nm are incident on the slit.

Answer: The slit width is e = 0.2 mm.

3. A lens of focal length 0.4 m and slit of width 0.2 mm are used to obtain diffraction pattern. Calculate the distance of first dark band and width of central maxima, if the wavelength of the light used is 500 nm.

Answer: The distance of first dark band from the central maxima =1 mm.
Hence the width of central maxima = 2 mm.

4. Determine the angles at which the first dark band and the next bright band are formed in the Fraunhofer diffraction pattern of a slit 0.3 mm wide (λ = 5890Å).

Answer: The angle at which first dark band is formed =6.44°.
The angle at which the next bright band is formed =9.66°.

5. A lens whose focal length is 40 cm forms a Fraunhofer diffraction pattern of a slit 0.3 mm width. Estimate the distances of the first dark band and of the next bright band from the axis (wavelength of light used is 5890 Å).

Answer: Distance of first dark band from the axis = 0.785 mm.
Distance of first bright band next to central maximum = 1.178 mm.

6. Find the half angular width of the central bright maximum in the Fraunhofer diffraction pattern of a slit of width $12X10^{-5}$cm when the slit is illuminated by monochromatic light of wavelength 6000 Å.

Answer: The half angular width of the central bright maximum is = 30°.

7. A granting has 6000 lines/cm. Determine the angular separation between two wavelengths 500 nm and 510 nm in the 3^{rd} order.

Answer: Hence angular separation between two wavelengths = 2.48°.

8. Find the highest order that can be seen with a grating having 15000 lines/inches. The wavelengths of the light used is 600 nm.

Answer: The highest order that can be seen is 2.

9. Monochromatic light of wavelength $6.56 X 10^{-7}$m falls normally on a grating 2 cm wide. The first order spectrum is produced at an angle of 18°15´ from the normal. Deduce the total number of lines on the grating.

Answer: The total number of lines on the grating = 9548.

10. How many orders will be visible if the wavelength of light is 5000 Å and the number of lines per cm on the grating is 5000?

Answer: The highest order that can be seen is 4.

11. In a grating show that only first order is possible if the width of the grating element is less than twice the wavelength of light.

12. Light form sodium vapor lamp is normally on a grating of 2 cm width having 10000 lines.

i) Find the angular separation of the two lines of sodium of wavelengths 5890 Å and 5896 Å in the first order spectrum?

Answer: The angular separation of two lines of sodium in the first order spectrum = 1´5´´.

Polarization

1. Estimate the Brewster angle for a glass slab (μ = 1.5) immersed in water (μ = 4/3).
   Answer: Brewster angle for the glass in water = 48˚22´.

2. Calculate the thickness of a half wave plate of quartz for a wavelength 500 nm. Here $\mu_e = 1.553$ and $\mu_0 = 1.544$.
   Answer: t = 0.0278 mm.

3. Quartz has refractive indices 1.553 and 1.544. Determine the thickness of the quarter wave plate for sodium light of wavelength 589 nm.
   Answer: t = 0.0164 mm.

4. Evaluate the thickness of a quarter wave plate for a monochromatic light of wavelength 600 nm, if the refractive indices of ordinary and extraordinary rays in the medium are 1.5442 and 1.5533 respectively.
   Answer: t = 16.48 μm = 0.0165 mm.

5. Estimate the minimum thickness of the half wave and quarter wave plates for a light beam (λ = 589.3nm) if $\mu_0 = 1.65833$ and $\mu_e = 1.48640$.

Answer: For half wave plate
t = 0.001713 mm
For quarter wave plate
t = 0.000857 mm.

6. The refractive index of calcite is 1.658 for ordinary ray and it is 1.486 for extraordinary ray. A slice having thickness $0.9X10^{-4}$ cm is cut from the crystal. For what wavelengths this slice we have as a (i) quarter wave plate (ii) half wave plate?
   Answer: For quarter wave plate
   λ = 619.2 nm
   for half wave plate
   λ = 309.6 nm.

7. A beam of linearly polarized light is changed into circularly polarized by passing it through a 30 µm thick birefringent crystal. Assuming its thickness is minimum and for a light of wavelength 589.3 nm incident on it normally, find the difference of refractive indices of the ordinary and extraordinary rays.
   Answer: 0.0049

8. A beam of plane polarized light is converted into a circularly polarized light by passing it through a crystal of slice thickness $3X10^{-5}$ cm. Calculate the difference in the refractive indices of the two rays inside the crystal assuming the above thickness to be the minimum value required to produce the observed effect wavelength of light used in 600 nm.