Assignment Sample Paper

Assignment No.-03

Unit III: WAVE OPTICS

1. In a Fresnel's bi-prism experiment, the distance between the slit and bi-prism is 10 cm and the distance between the bi-prism and eyepiece is 90 cm. If the distance between two coherent sources is 0.3 mm and the wavelength of light used is 5893 Å, calculate the fringe width.
2. A wedge-shaped film of refractive index 1.4 is illuminated by monochromatic light of wavelength 5800 Å. If the number of fringes per cm is 10, calculate the angle of the wedge.
3. In Newton's rings experiment, the diameter of the nth dark ring was 0.3 cm and that of the (n+10)th ring was 0.8 cm. If the radius of curvature of the plano-convex lens is 100 cm, find the value of n and wavelength of light.
4. A slit of width 0.3 mm is illuminated by white light. A screen is placed 1.5 m away from the slit. Calculate the width of the central maximum for wavelength 6500 Å.
5. A parallel beam of monochromatic light of wavelength 5000 Å is incident normally on a plane diffraction grating having 4000 lines per cm. Calculate the angle of diffraction for the second-order principal maximum.
6. A grating 2 cm wide has 6000 lines. Find the smallest wavelength difference that can be resolved in the third order at a wavelength of 5000 Å.
7. State and explain the principle of superposition of waves. Derive the conditions for constructive and destructive interference.
8. Explain how Fresnel's bi-prism can be used to determine the thickness of a thin transparent sheet.
9. Why are Newton's rings circular? Why is the central spot dark in reflected light?
10. Explain Fraunhofer diffraction at a single slit. Why is the intensity of the central maximum much greater than the secondary maxima?
11. Derive the grating equation for normal incidence. Explain the formation of principal maxima and minima.
12. What do you understand by resolving power of an optical instrument? State and explain Rayleigh's criterion for resolution.
13. **Derive the expression for the diameter of Newton's rings in reflected light.** Show that $D^2_n = 4n\lambda R$ for dark rings, where n is the order, λ is wavelength, and R is radius of curvature.

Assignment – 04

UNIT IV: LASERS AND FIBRE OPTICS

1. If the spontaneous emission rate is 10^7 s^{-1} and stimulated emission rate is 10^9 s^{-1} for a laser transition at wavelength 600 nm, calculate the ratio of the Einstein coefficients A/B.
2. A step-index fiber has a core refractive index of 1.50 and a cladding refractive index of 1.45. Calculate: (a) the critical angle at the core-cladding interface (b) the numerical aperture (c) the acceptance angle.
3. An optical fiber has a core diameter of 60 μm, core refractive index of 1.47, and cladding refractive index of 1.45. Calculate: (a) V-number at $\lambda = 0.85$ μm (b) number of modes that can propagate.
4. A fiber optic link has a total loss of 30 dB. If the input power is 1 mW, calculate the output power.
5. Explain the terms: (a) Spontaneous emission (b) Stimulated emission (c) Absorption. Compare spontaneous and stimulated emission.
6. Describe the construction and working of Nd:YAG laser with a neat diagram.
7. Explain the construction and working principle of CO_2 laser. What are its advantages?
8. What is total internal reflection? Derive the condition for total internal reflection.
9. Define and explain the following terms related to optical fibers: (a) Acceptance angle (b) Acceptance cone (c) Numerical aperture.
10. Explain with diagrams: (a) Multi-mode step-index fiber (b) Multi-mode graded-index fiber (c) Single-mode step-index fiber.
11. Explain different types of losses (attenuation) in optical fibers: (a) Absorption losses (b) Scattering losses (c) Bending losses.
12. Explain the use of optical fibers in internet and telecommunication networks.
13. **Derive the relation between Einstein's A and B coefficients.** Under thermal equilibrium, show that $A_{21}/B_{21} = (8\pi h\nu^3/c^3)$.

Assignment No. - 05

UNIT V: DIELECTRICS AND ELECTRON BALLISTICS

1. A parallel plate capacitor with plate area 100 cm^2 and separation 1 cm is filled with a dielectric of relative permittivity 5. If the applied voltage is 100 V, calculate: (a) the electric field (b) the displacement vector D (c) the polarization P.
2. The electric susceptibility of a dielectric material is 3.5. Calculate its dielectric constant and relative permittivity.
3. The dielectric constant of a material at 27°C is 6.5. If the electronic polarizability is 2×10^{-40} $F \cdot m^2$ and ionic polarizability is 4×10^{-40} $F \cdot m^2$, calculate the orientational polarizability. Given: number density $N = 5 \times 10^{28}$ $/m^3$.
4. An electron is accelerated through a potential difference of 500 V. Calculate its final velocity. (Given: $e = 1.6 \times 10^{-19}$ C, $m = 9.1 \times 10^{-31}$ kg)
5. What is dielectric polarization? Explain the physical meaning of polarization vector P.
6. Distinguish between polar and non-polar dielectrics with examples.
7. State and prove Gauss's law in dielectrics.
8. Define and explain: (a) Electric displacement vector D (b) Polarization vector P (c) Electric field intensity E. Establish the relationship between them.
9. Explain different types of polarization in dielectrics: (a) Electronic polarization (b) Ionic polarization (c) Orientational polarization (d) Space charge polarization.
10. Explain the frequency dependence of total polarization with a suitable diagram.
11. Derive the equation of motion of a charged particle in a uniform electric field.
12. What is the trajectory of an electron moving in a uniform transverse electric field? Derive the equation.
13. Derive the expression for the radius of circular path of a charged particle moving perpendicular to a uniform magnetic field.
14. What is a mass spectrograph? Explain its principle.
15. Describe the construction and working of Aston mass spectrograph with a neat diagram.
16. Describe the construction and working of Bainbridge mass spectrograph with a neat diagram.