

Module-2 : Optics

1. (a) Find out the expression for intensity pattern for single slit diffraction. Find out the maxima and minima condition. Show the intensity pattern graphically.
(b) In a double slit experiment, the slit width is 0.16 mm and spacing between the two slits is 0.8 mm. What are the missing orders in the diffraction pattern.
2. (a) What are O-ray and E-ray? How the nicol prism acts as analyser.
(b) Define optic axis. What are positive and negative crystals?
(c) Calculate the thickness of a mica sheet required to make a quarter wave-plate for $\lambda=546$ nm. The refractive indices for the O-ray and E-ray in mica are 1.586 and 1.592 respectively. Is it a positive or negative crystal?
3. (a) Write down the conditions for maxima and minima in case of Newton's ring experiment.
(b) Why is the centre of Newton's rings dark in case of thin air film in reflected mode?
(c) A film of oil of refractive index 1.7 is placed between a plane glass plate and an equi-convex lens. The focal length of the lens is 1 metre. Determine the radius of the 10th dark ring when wavelength of light is 6000 Å.
4. (a) Write the expression of intensity of grating spectra.
(b) Deduce the condition for principal maxima of grating spectra.
(c) Find the difference of energy between two energy levels of Ne atom if the transition between these levels gives a photon of wavelength 632.8 nm. Calculate the number of photons emitted per second to give a power output of 2 milliwatt.
5. (a) Write down the expression for intensity of double slit diffraction pattern.
(b) Establish the conditions for different maxima's and minima's.
6. What is 'Pumping' and 'Population Inversion' in LASER.
7. How can you detect an unpolarized light, circularly polarized light and the mixture of two.
8. Define Brewster's law in polarization with proper diagram. What is the ratio of two gases in He-Ne laser.
9. Establish the relation between Spontaneous and stimulated emission probabilities and hence find out the relation between field energy and Einstein's 'A', 'B' coefficient.
10. Write down the condition of interference of light. Distinguish between interference by division of amplitude and interference by division of wavefront with example.
11. Show that the radius of the dark ring in Newton's ring is proportional to the square root of natural number.
12. Explain Brewster's law in polarization. Hence show that the angle between the reflected and refracted rays is 90°.
13. How can you distinguish unpolarized, linear polarized, circular polarized, and elliptical polarized light?
14. Explain the working principle of He - Ne laser with energy level diagram.
15. What are the metastable states? What are the differences between ordinary light and laser light?

16. What is retardation plate? A plane polarized light of wavelength 600 nm changes to a circularly polarized light on passing through a quartz crystal cut parallel to optic axis. Calculate the minimum thickness to produce such effect. Given $\mu_e - \mu_o = 0.005$.
17. Define with examples: uniaxial crystal, biaxial crystal, positive crystal and negative crystal. Find the polarizing angles for a glass of refractive index 1.52. Also find the angle of refraction
18. Distinguish between spontaneous and stimulated emission. Define Malus law in polarization. Find the state of polarization when the x and y components of electric field are given by $E_x = E_1 \sin(\omega t + kz)$ and $E_y = E_2 \cos(\omega t + kz)$.
19. In a Newton's ring experiment, the diameter of 5th dark ring is 0.336 cm and the diameter of the 15th dark ring is 0.590 cm. Find the radius of the plano-convex lens if the wavelength of the light used is 589 nm.

Module-1 : Oscillation

1. (a) Establish the differential equation for the damped harmonic oscillator and explain each term. Find the general solution of the motion.
(b) Derive the expression of displacement for underdamped motion and draw a graph.
2. (a) Find out the frequency at which the amplitude resonance occurs.
(b) How quality factor and bandwidth are related in mechanical system.
3. (a) Establish the differential equation of a forced harmonic oscillator explaining each term. Write the expression for displacement mentioning the steady state.
(b) Calculate the value of frequency (in Hz) of L-C oscillation with $L = 200 \text{ mH}$ and $C = 80 \mu\text{F}$.
4. Define the following terms in connection with the damped simple harmonic motion of a particle: (a) relaxation time (b) logarithmic decrement.
5. Draw and write down the differential equation of a series L-C-R circuit driven by a sinusoidal voltage.
6. Establish SHM and calculate the time period of the liquid column of length L in a U-tube, if it is depressed in one arm by y , δ is the density of the liquid and α is the cross-sectional area of the arm of the U-tube.
7. Establish a differential equation of SHM and derive the total energy of SHM.
8. What is resonance? Establish the condition for velocity resonance for a mechanical system.
9. An oscillatory mass of 10 gm is acted on by a restoring force constant of 5 dyne/cm and a damping force constant of 2 dyne-sec/cm. Find whether the motion is overdamped or oscillatory. Find the resisting force per unit velocity which will make the motion critically damped.
10. What is decay constant (or relaxation time)? How does it vary with damping coefficient?
11. A particle is executing SHM. At an instant of time its displacement is 12 cm and velocity is 5 cm/s, when displacement is 5 cm, velocity is 12 cm/s. Calculate its amplitude, frequency and time period.
12. Derive the expression for total energy of a simple harmonic oscillator and show that it is constant and proportional to the square of the amplitude. Show the variation of kinetic energy, potential energy, total energy in a single graph. Calculate the displacement to amplitude ratio for a SHM when the kinetic energy is 90% of the total energy.