## QUESTIONS

1. What is free oscillation? Derive an expression for differential equation of fre oscillations.
2. Derive an expression for differential equation of damped oscillations and obtain it general solution.
3. Derive an expression for differential equation of forced oscillations and obtain its genera solution.
4. Derive the differential wave equation of wave motion.

$$\frac{d^2y}{dt^2} = \frac{1}{v^2}\frac{d^2y}{dx^2}$$

5. Set up differential equation of forced vibrations and prove

$$A = \frac{f}{\sqrt{[(\omega^2 - p^2)^2 + 4b^2p^2]}}$$

$$\theta = \tan^{-1}\left(\frac{2bp}{\omega^2 - p^2}\right)$$

6. What are forced vibrations? Obtain the differential equation of forced vibrations and fin the amplitude of forced vibrations and its phase.
7. What are damped oscillations? Obtain the differential equation of damped oscillations and find its general solution.

## QUESTIONS

1. What is magnetostriction effect? Explain the production of ultrasonic wave using magnetostriction oscillator
2. What is piezoelectric effect? Explain the production of ultrasonic wave using piezoelectric oscillator.
3. Write any four applications of ultrasonic waves.
4. Explain:
   (a) Piezo-electric effect
   (b) Magnetostriction effect
5. A piezoelectric crystal of thickness 4mm produces ultrasonic waves of frequency 400 kHz. Calculate the thickness of this crystal to produce ultrasonic frequency of 500 kHz.

   [Ans.: 3.2 mm]
6. Calculate the natural frequency of the ultrasonic waves generated by a quartz crystal having thickness of 5.5 mm. Given Y= 80 GPa, $\rho = 2650\ kg/m^3$

   [0.49Hz]
7. Calculate the length of an iron rod which can be used to produce ultrasonic waves of frequency 20 kHz. Given: $Y = 11.6 \times 10^{10}\ N/m^2, \rho = 7.23 \times 10^3 kg/m^3$

   [$l$ = 0.1 m]
8. Calculate the fundamental frequency of quartz crystal 1mm thick and density 2650kg/m$^3$ and Y=8x10$^{10}$N/m$^2$

   [Ans.: $f$ = 2.747$MHz$]

## QUESTIONS

1. Explain the formation of the Newton's Rings. Prove that in Newton's Rings by reflected light, the diameters of bright Rings are proportional to square root of odd natural numbers.
2. A thin film of uniform thickness is illuminated by monochromatic light. Obtain the conditions of darkness and brightness of the film as observed in reflected light.
3. Why the centre of Newton's Rings appears dark in reflected light.
4. Why Newton's Rings are circular?
5. Discuss the interference of light in thin film.
6. In case of Newton's rings, prove $D_n \propto \sqrt{n}$ where $D_n$ is diameter of $n^{th}$ dark ring.
7. Explain the interference of light in wedge shaped film and prove that for air film

$$\beta = \frac{\lambda}{2\theta}$$

8. Explain theory of Newton's rings for reflected light.
9. Light of wavelength 5500 Å falls normally on a thin wedge shaped film of R.I. 1.4 forming fringes that are 2.5 mm apart. Find the angle of wedge.

   [Ans.: $\theta = 7.85 \times 10^{-5}$ radian]

10. Newton's rings are observed in the reflected light of wavelength 5900Å. The diameter of tenth dark is 0.5 cm. Find the radius of curvature.

    [Ans.: $R = 1.059m$]

11. Light of wavelength 5880 Å is incident on a thin film of glass (μ=1.5) such that the angle of refraction in the plate is 60°. Calculate the smallest thickness of plate which will make it dark by reflection.

    [Ans.: $t = 3920$ Å]

12. A parallel beam of light (λ=5870Å) is incident on a thin glass plate (μ=1.5), such that the angle of refraction into the plate is $60^0$. Calculate the smallest thickness of the glass plate which will appear dark by reflection.

    [Ans.: $t = 3913$ Å]

13. In Newton's ring experiment the diameter of the 15th ring was found to be 0.59cm and that of the 5th ring was 0.336cm. If the radius of the Plano-convex lens is 100cm. Calculate the wavelength of light used.

    [Ans.: $\lambda = 5893$ Å]

14. A wedge-shaped air film is formed between two glass plates by placing a paper at one end. On illuminating this film by light of $600nm$ wavelength. 10 fringes are seen in 10mm. If light is incident normally. Find the angle of wedge. [Ans. 61.9°]
15. In Newton's rings experiment, the diameter of the $5^{th}$ ring was 3.36mm & the diameter of the $15^{th}$ ring was 5.90mm. Find the radius of curvature of the Plano-convex lens if the wavelength of the light used is 589nm. [Ans.0.99m]

## QUESTIONS

1. Explain with diagram the principle and working of Ruby Laser.
2. Explain the principle and working of He-Ne gas laser
3. What does LASER stand for? In what respects it differs from an ordinary source of light?
4. Explain spontaneous and stimulated emission of radiation.
5. What is the importance of metastable state and pumping in the production of Laser?
6. What is active material in He-Ne laser? How population inversion is achieved in a He-Ne laser?

## QUESTIONS

1. What is acceptance angle for an optical fibre? Obtain mathematical expression for acceptance angle and numerical aperture.
2. Discuss the principle of fibre optics. Explain acceptance angle and numerical aperture.
3. Explain the principle of the optical fibre as a waveguide for light. Discuss different types of fibres.
4. Calculate the numerical aperture of an optical fibre when the core refractive index is 1.55 & the cladding refractive index is 1.33

   [Ans. NA=0.795]
5. Determine the numerical aperture of a step index fibre when the core refractive index is 1.5 & the cladding refractive index is 1.48. Find the maximum angle for entrance of light, if the fibre is placed in air.

   [Ans. (1) NA=0.2441, (2) 14.13°]
6. If the maximum angle of incidence is 45°for entrance of light for a fibre placed in air, calculate the numerical aperture. What is the acceptance angle?

   [Ans. (1) NA = 0.7071, (2) 90°]
7. Refractive index $\mu_1 = 1.48$ & $\mu_2 = 1.45$ in an optical fibre. Calculate numerical aperture & the maximum acceptance angle $\theta_{max}$ if the fibre is kept in air.

   [NA = 0.2964, $\theta_{max} = 17.24°$]
8. Calculate the numerical aperture and hence the acceptance angle for an optical fiber. Given that the R.I. of the core and the cladding are 1.45 and 1.40 respectively.

   [Ans.: NA = 0.37, $\theta_m = 22.17°$]
9. The numerical aperture of an optical fiber is 0.5 and Core refractive index is 1.54. Find the refractive index of the cladding.

   [Ans.: $n_2 = 1.456$]
10. A fibre cable has an acceptance angle of 30° and a core refractive index 1.4. Calculate the refractive index of cladding.

    [Ans.: $n_2 = 1.30$]
11. Calculate the numerical aperture and acceptance angle of optical fibre of refractive index for core and cladding are 1.62 and 1.52 respectively.

    [Ans.: NA = 0.56, $\theta_m = 34.08°$]
12. Calculate the refractive indices of the core and cladding material of a fibre having NA=0.22 and Δ=0.012.

    [Ans.: $n_1 = 1.42$, $n_2 = 1.403$]
13. If the acceptance angle for a given fibre is 68.16°. Calculate the maximum ent[illegible]ngle and numerical aperture. If the cladding glass has a R.I. 1.52 calculate the ref[illegible]ex (R.I.) of the core glass.

    [Ans.: $\theta_m = 34.08°$, NA = 0.5[illegible]

## QUESTIONS

1. What is Uncertainty principle? Using this principle prove that electron cannot exist in the nucleus.
2. Derive time independent Schrodinger wave equation. What is wave function?
3. Derive time dependent Schrödinger wave equation. What is physical significance of wave function?
4. An electron starts from a rest and moves freely in an electric field of intensity 1500 V/m. Determine the acceleration attained by the electron.
5. Explain the construction and working of G.M. counter.
6. What is dead time and recovery time in G. M. counter? What do you mean by quenching?
7. Give applications of G. M. counter. What are its limitations?
8. If the uncertainty in position of an electron is $4 \times 10^{-10}$m, Calculate the uncertainty in its momentum.

   [Ans. $\Delta p = 1.31 \times 10^{-25} kg\ m/s$]
9. What is the wavelength associated with an electron having K.E. equal to 1MeV.
10. For an electron moving with a velocity $3 \times 10^7 m/s$. Estimate the smallest possible uncertainty in the position of the electron.

    Given: $m_e = 9.1 \times 10^{-31} kg, \ \ \hbar = 1.05 \times 10^{-34}\ J - s$

    Ans. $\Delta x = 0.038$Å
11. An electron is confined to a box of $10^{-9}m$ length. Calculate the minimum uncertainty in its velocity

    [Ans. $\Delta v = 7.3 \times 10^5 m/s$]
12. If the uncertainty in position of an electron is $4 \times 10^{-10} m$. Calculate the uncertainty in its momentum.

    [Ans. $\Delta p = 1.65 \times 10^{-24} kg\ m/s$]
13. An electron has speed of $400 m/s$ with uncertainty of 0.01%. Find the accuracy in its position.

    [Ans. $\Delta x = 2.898 \times 10^{-3} m$]
14. An electron has a speed of $900 m/s$ with an accuracy of 0.001%. Calculate the uncertainty with which the position of the electron can be located.

    [Ans. $\Delta x = 0.01288 m$]

## QUESTIONS

1. Explain different types of lattice in cubic system. What is packing density? Find the packing density for SC, BCC and FCC lattices.
2. Derive the relation between lattice constant and density of the cubic crystal.
3. State and derive Bragg's Law of X-ray diffraction.
4. State and prove Moseley's law. What is its importance?
5. What are X-rays? Explain continuous and characteristics X-ray spectrum and their origin.
6. Deduce relation between an interplaner distance 'd', lattice constant 'a' and Miller indices of planes (hkl) for cubic crystal.
7. Derive an expression for the interplanar distance in terms of Miller indices for a cubic structure, Calculate the ratio $d_{100} : d_{110} : d_{111}$.
8. Lithium has BCC structure. Calculate the lattice constant, given that the atomic weight and density are 6.94 and 530 $kg/m^3$ respectively.

   [Ans.: $a = 3.516$Å]

9. The interplaner spacing of (100) plane is 2 Å for a FCC crystal. Find the atomic radius.

   [Ans.: $r = 0.70$Å]

10. An electron is accelerated through 1000 volts and is reflected from a crystal. The first order reflection occurs when glancing angle is 70°. Calculate interplaner spacing of a crystal.

    [Ans.: $d = 6.59$Å]

11. Calculate the lattice constant of iron which has BCC structure. Given $\rho = 7.86\ gm/cc$, A=55.85

    [Ans.: $a = 2.861$Å]

12. Silver has FCC structure and its atomic radius is 1.414Å. Find the interplaner spacing for (200) planes.

    [Ans.: $d_{200} = 2.037$Å]

13. Calculate the glancing angle on the plane (100) for rock salt crystal (a= 2.125Å). Consider the case of second order maximum and wavelength of X-ray is 0.592Å.

    [Ans.: $\theta_2 = 16.17°$]

14. Calculate the glancing angle on cube (100) of a rock salt having lattice constant 2.81Å, corresponding to the first order Bragg's diffraction to X-rays of wavelength 1.54Å

    [Ans.: $\theta = 15.9°$]

15. Calculate lattice constant and atomic radius for chromium having BCC structure. Given : density 5.98 gm/cc and atomic weight 50.

    [Ans.: $a = 3.031$Å, $r = 1.31$Å]

## QUESTIONS

1. What is superconductivity? Explain type-I and type-II superconductors.
2. What is Meissner effect and effect of external magnetic field on superconducting state of material?
3. At 6 K, critical field is $5 \times 10^3$ A/m. Calculate transition temperature when critical field is $2 \times 10^{14}$ A/m at 0 K.

   [Ans.: $T_C = 6.928K$]
4. Explain Meissner effect in superconductor.
5. A superconducting lead has a critical temperature of $7.26K$ at zero magnetic field and a critical field of $8 \times 10^5\ A/m$ at $0K$. Find the critical field at $5K$.

   [Ans. $4.2 \times 10^5\ A/m$]
6. Superconducting Nb has a critical temperature of $9.15K$ at zero magnetic field and critical field of a $0.1960T$ at $0K$. Find the critical field at $5K$.

   [Ans. $0.137T$]
7. The critical field for niobium is $1 \times 10^5\ A/m$ at $8K$ and $2 \times 10^5 A/m$ at absolute zero. Find the transition temperature of the element.

   [Ans.: $T_c = 11.3K$]
8. Find the critical field for lead at $T = 4.2KT_c = 7.2K$ and $B_c(0)$ for lead is $0.0803\ Wb/m^2$.

   [$B_c(T) = 0.0548\ T$]
9. Calculate the critical current which can flow through a long thin superconducting wire of aluminum of diameter $1mm$. The critical magnetic field for aluminum is $7.9 \times 10^3 A/m$.

   [Ans.: $24.806A$]
10. A superconducting tin has a critical temperature of $3.7K$ in zero magnetic field & a critical field of $0.0306T$ at $0K$. Find the critical field at 2K.

    [Ans.: $0.02165\ T$]
11. Calculate the magnetic field in lead at $5K$. If it's critical magnetic field at $0K$ is $8 \times 10^5 A/m$ and superconducting transition temperature $T_c = 7.26K$

    [Ans.: $4.2 \times 10^5\ A/m$]

## QUESTIONS

1. What is Hall effect? Derive an expression for Hall Coefficient and mobility of charge carriers. Discuss two of its applications.

2. What is Hall Effect? Derive the expression for Hall coefficient for n and p type semiconductor.

3. The conductivity and the Hall Coefficient of N-type semiconductor are 112 mho/m and $1.25 \times 10^{-4}$ $m^3/C$ respectively. Calculate the charge carrier density and electron mobility.

   [Ans.: $n = 5 \times 10^{22}\ electron/m^3$, $\mu_e = 0.014\ m^2/V\text{-}s$]

4. The intrinsic carrier density at room temperature in Ge is $2.37 \times 10^{19}$ $/m^3$. If the electron and hole mobilities are 0.38 and 0.18 $m^2/V.s$ respectively, calculate its resistivity.

   [Ans.: $0.4717\ \Omega m$]

5. The mobilities of carriers in intrinsic germanium sample at room temperature are $\mu_c = 3600\ cm^2/volt - sec$, $\mu_p = 1700\ cm^2/volt - sec$. If the density of electrons is same as holes and is equal to $2.5 \times 10^{13} per\ cm^3$. Calculate the conductivity.

   [Ans.: $\sigma = 2.12\ mho/m$]