Program/Course: B.Tech.
(Sem. – 1st /2nd)
Name of Subject: Physics
Subject Code: BSC-101
Paper ID: 15925
Scientific calculator is allowed

Time Allowed: 3 Hours   Max. Marks: 60

NOTE:

1) Part A and Part B are compulsory.
2) Part C has two questions Q8 and Q9. Both are compulsory, but with internal choice.
3) Any missing data may be assumed appropriately.

Part – A   [Marks: 02 each]

Q1.

(a) Define numerical aperture of an optical fibre and give its physical significance.

(b) Differentiate damped and undamped oscillations.

(c) Define Fermi level. How it varies with temperature in intrinsic semiconductors?

(d) What is wave function? Give the physical significance of wave function.

(e) Find divergence and curl of position vector **r**.

(f) What is hysteresis? Based on it, differentiate hard and soft magnetic materials.

Part – B   [Marks: 04]

Q2. Derive Maxwell's electromagnetic wave equation for free space and show that speed of em waves in free space is 3×10^8 m/s. Also comment on the nature of em waves.

Q3. Differentiate spontaneous and stimulated emission. Discuss on what factors the rate of stimulated absorption per unit volume (R_a) and rate of stimulated emission per unit volume (R_{sti}) depend. Write their mathematical expressions. Hence find condition when rate of stimulated emission per volume will be more than rate of stimulated absorption per unit volume.

Q4. What is the difference between intrinsic and extrinsic semiconductors? Explain two types of extrinsic semiconductors.

Q5. (i) Compare any four properties of paramagnetic and ferromagnetic substances.

(ii) Discuss briefly the factors responsible for change in properties when we move from bulk to nanomaterial.

Q6. Calculate the de-Broglie wavelength of an electron whose kinetic energy is 50 eV. Given $h = 6.62 \times 10^{-34}$ joule-sec, $m_e = 9.1 \times 10^{-31}$ kg, $1 eV = 1.6 \times 10^{-19}$ joule.

Q7. Establish the equation of a simple harmonic oscillator. Using $x(t) = A\sin(\omega t + \phi)$ with symbols having their usual meaning. Find kinetic energy and potential energy associated with SHM. Hence show that total energy of a simple harmonic oscillator is constant any instant of time. (4)

Part– C   [Marks: 12]

Q8.

(a) Describe the principle, construction and working of any gaseous state laser with the help of neat diagrams. (4)

(b) Write four Maxwell equations both in integral form and differential form. Explain physical significances of each equation. (4)

(c) A step index fibre with a large core diameter compared with the wavelength of the transmitted light has an acceptance angle in air of 30^0 and fractional refractive index difference of 0.03. Determine (i) numerical aperture of the fibre (ii) the critical angle at the core cladding interface (iii) necessary core radius for fiber to be multimode if the wavelength of transmitted light is 950nm. (4)

OR

(a) What is the structure of an optical fibre? Explain the principle of propagation of light within a fibre. Find mathematical expression of acceptance angle of an optical fibre and also define it. (4)

(b) Derive mathematical relationship between electric field vector **E** and electric potential V. Also find curl of **E** if **E** is electrostatic. (4)

(c) A step index fibre has normalized frequency V=26.6 at 1300nm wavelength. If the core radius is 25μm, calculate the numerical aperture and hence find the value of acceptance angle. (4)

Q9.

(a) For a given superconducting sample, values of critical magnetic field corresponding to 14K and 13K respectively are 2.8×10^5 A/m and 5.6×10^5 A/m. Find critical temperature T_c and critical magnetic field value at 0K. (4)

(b) Derive London equations and discuss their significance. (5)

(c) An electron is confined to a one-dimensional potential box of length 0.1nm. Calculate the difference in energies corresponding to the ground state and first excited state in eV. Given $m_e = 9.1 \times 10^{-31}$ kg, h= 6.626×10^{-34} Joule-sec. (3)

OR

(a) For a given superconducting sample, the values of critical magnetic field corresponding to 0K and 5K respectively are 10×10^6 A/m and 5×10^6 A/m. Find wavelength of a photon required to break Cooper pairs in the superconductor. Given Boltzmann's constant k = 1.38×10^{-23} J/K. (4)

(b) Define critical magnetic field [$H_c(T)$] associated with the phenomenon of superconductivity and give its significance. Explain Meissner effect and hence differentiate type I and type II superconductors. (5)

(c) An electron is confined to a one-dimensional potential box of length $2A^0$. Calculate the energies corresponding to the second and fourth quantum state in eV. ($m_e = 9.1 \times 10^{-31}$ kg, h= 6.626×10^{-34} Joule-sec.) (3)

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