**Please check that this question paper contains 09 questions and 02 printed pages within first ten minutes.**

[Total No. of Questions:09]
[Total No. of Pages: 02]

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Program/ Course: B.Tech. (Sem $1^{st}/2^{nd}$)
Name of Subject: Physics
Subject Code: BSC-101
Paper ID: 15925

Time Allowed: 03Hours
**Max. Marks:60**

**NOTE:**

1) **Parts Aand 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
4) Use of scientific calculator is allowed

## Part – A

**[Marks: 02 each]**

**Q1.**

a) Define Hooke's law.
b) Calculate energy of an electron which is moving in 1-D box of width 1 Å. Consider the electron to be in first excited state.
c) Intrinsic semiconductors behave as insulators at 0K. Comment.
d) What are nanomaterials? How can we classify them?
e) Give physical significance of Poynting vector.
f) In word LASER, A should be replaced by O. Comment.

## Part – B

**[Marks: 04 each]**

**Q2.** Derive time independent Schrodinger equation for the 1-D motion of a restricted particle. Also give the shortcomings of Schrodinger equation, if any.

**Q3.** Write short note on (i) Dielectric materials (ii) Ferromagnetic materials.

**Q4.** What are oscillations? Explain briefly free oscillations, damped oscillations and forced oscillations.

**Q5.** Show that for intrinsic semiconductors, Fermi level lies in the middle of energy gap.

**Q6.** In a given laser, total number of lasing particles is $2.8 \times 10^{19}$. If laser emits a wavelength of 6328 Å, then calculate the energy of one photon being emitted by the laser. If the laser beam is focused on an area equal to the square of its wavelength for 1s, find intensity of the focused beam. Assume the efficiency of laser to be 100%.

**Q7.** The scalar potential at a point is given by $V = 2x - 4xy + 3z^2$. Find electric field intensity vector and then check whether the field vector is solenoidal or not.

## Part – C

**[Marks: 12 each]**

**Q8.** (a) Derive the differential form of Gauss law of electrostatics and Gauss law of magnetostatics. Give significance of each equation.

(b) Derive mathematical relation amongst Einstein coefficients and find condition(s) for lasing action to take place. Also find the units of Einstein coefficients.



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(c) Enlist various losses taking place in an optical fibre.

**or**

(a) Derive Maxwell's electromagnetic (em) wave equation for free space and show that speed of em waves in free space is $3 \times 10^8$ m/s.

(b) Why four level laseris better than three level laser? Explain the construction and working of any four-level laser. Trace well labelled energy level diagram(s) for the same.

(c) Find acceptance angle, numerical aperture, critical angle and V-number of the optical fibre from the data given below:
Refractive index of core = 1.48, Fractional change in refractive index = 0.005, core radius 'a' = 50 μm, wavelength of radiation $\lambda = 850$ nm. Check whether the fibre is single mode or multimode.

**Q9.** (a) The instantaneous displacement of a particle executing SHM is given by $y = A \sin(\omega t + \phi)$. If the displacement of the particle at t=0 be $y_o$ and the velocity at t=0 be $v_o$, then find the values of A and $\phi$. Symbols have their usual meanings.

(b) Apply time independent Schrodinger equation to discuss the motion of a particle in 1-D box. Find eigen wavefunctions and energy eigen values of the moving particle.

(c) An electron and proton are moving with same speed. Which particle will be having large value of de-Broglie wavelength and why?

**or**

(a) Develop equation of motion of SHM. Find expression for time period, potential energy, kinetic energy and total energy of SHM.

(b) Derive London equations for Type I superconductors. Show that no electric field is required for steady current to flow through a superconductor. Using these equations, explain the concepts of flux penetration and flux expulsion.

(c) Find the wavelength of a photon which can break a Cooper pair if the critical temperature of a superconductor is 5K.

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