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Uni. Roll No. ....

MORNING

Program Course: B.Tech.  
(Sem. - 1<sup>st</sup>/2<sup>nd</sup>)

Name of Subject: Physics

Subject Code: BSC-101

Paper ID: 15925

Use of 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) What do you mean by total internal reflection (TIR)? Give two examples of TIR in daily life.
- (b) Given a simple harmonic motion defined by  $x(t) = 2 \sin(0.7\pi t - \pi/6)$ . Find the amplitude, natural frequency, time period and wavelength of the given SHM.

- (c) What are semiconductors? How are semiconductors different from conductors and insulators?

- (d) Differentiate polar and non-polar dielectric materials.

- (e) The restoring force acting on the spring is 9.8 N and its spring constant is 490N/m, find the extension in the spring. If the restoring force is halved, then find the change in the extension of spring.

- (f) A laser beam having intensity  $2\text{mW/m}^2$  is passed through a circular cross-sectional area of  $1\text{mm}^2$ . Find energy of the photons emitted by laser in 1s.

Part B

[Marks: 04]

- Q2. State Gauss law of electrostatics and hence show that  $\vec{\nabla} \cdot \vec{E} = \frac{\rho}{\epsilon_0}$ , where symbols have their usual meaning. Give physical significance of this equation. Under what condition, the electrostatic field will become solenoidal in nature?

- Q3. What is damped oscillator? Name the forces acting on the oscillator when its oscillations are damped. Develop the equation of motion and discuss three possible cases of damped oscillations.

- Q4. Differentiate (i) n type and p type semiconductors (ii) drift current and diffusion current.

- Q5. (i) Given  $\vec{A} = x^2\hat{i} + y\hat{j} + 2xyz\hat{k}$ . Find curl and divergence of vector field  $\vec{A}$  at point (2,1,-1). Comment on the nature of vector field  $\vec{A}$ , whether it is rotational/irrotational, source/sink or solenoidal field.

- (ii) Given electric scalar potential  $V(x,y,z) = (\log x + 2y - 3xyz)$  Volts. Find the electrostatic field vector  $\vec{E}$  and its magnitude at point (1,1,0).

- Q6. State de-Broglie hypothesis. Calculate the speed with which an electron will be moving if de-Broglie wavelength associated with an electron is 5 Å. Also find the kinetic energy of the electron in eV. Given  $h = 6.62 \times 10^{-34}$  joule-sec,  $m_e = 9.1 \times 10^{-31}$  kg,  $1\text{eV} = 1.6 \times 10^{-19}$  joule.

- Q7. An electron is confined to a one-dimensional potential box of length  $1\text{Å}$ . Calculate the difference in energies corresponding to the ground state and first excited state. Hence find wavelength of the photon which can excite the electron to first excited state. ( $m_e = 9.1 \times 10^{-31}$  kg,  $h = 6.626 \times 10^{-34}$  Joule-sec,  $c = 3 \times 10^8$  m/s.)

Part-- C

[Marks: 12]

Q8.

- (a) Describe the principle, construction and working of He-Ne laser with the help of neat diagrams. (4)

- (b) Explain briefly the following terms in context with lasers:

- (i) Population inversion (ii) Pumping (iii) Spontaneous emission (iv) Laser medium. (4)

- (c) A step index fibre has an acceptance angle of  $60^\circ$  in air. The refractive index of core is 1.50. Determine (i) numerical aperture of the fibre (ii) the critical angle at the core cladding interface (iii) fractional change in refractive index (iv) necessary core radius for the fiber to be single mode if the wavelength of transmitted light is 1200nm. (4)

OR

- (a) What do you mean by the term numerical aperture in context with an optical fiber? Find mathematical expression of numerical aperture of an optical fiber in terms of (i) acceptance angle (ii) fractional change in refractive index ( $\Delta$ ). (4)
- (b) Differentiate (i) Step index fiber and Graded index fiber (ii) Single mode fiber and multimode fiber. (4)
- (c) A step index multimode fibre has normalized frequency  $V=10.5$  at 850nm wavelength. If the core radius is 80 $\mu$ m. Find the value of numerical aperture. Hence calculate the value of acceptance angle. If the fractional change in refractive index is 0.005; find the refractive indices of core and clad of the fiber. Assume the surrounding medium to be air. (4)

Q9.

- (a) For a given superconducting sample, values of critical magnetic field corresponding to 14K and 0K respectively are  $2.8 \times 10^5$  A/m and  $8.4 \times 10^5$  A/m. Find critical temperature  $T_c$  of the given superconducting sample. Also find the critical magnetic field values at 12K and 15K. (4)
- (b) Explain Meissner effect. Differentiate type I and type II superconductors. (2+2)
- (c) Write short note on the following materials: (i) Nanomaterials (ii) Ferrites. Also mention some of their salient applications. (2+2)

OR

- (a) For a given superconducting sample, the value of critical magnetic field corresponding to 0K is  $10 \times 10^6$  A/m. The value of critical magnetic field corresponding to some unknown temperature 'T' K is  $5 \times 10^6$  A/m. Find the value of unknown temperature if critical temperature for the given superconductor is 7K. Also find value of critical magnetic field at 6K. (4)
- (b) Find surface area to volume ratio for a sphere having radius 5m. This sphere is then divided into 1000 smaller spheres. Find the radius of one such smaller sphere. Also find the surface area to volume ratio for these 1000 spheres. Does this new ratio same/more/less than the original ratio? (4)
- (c) Compare any four properties of (i) diamagnetic, paramagnetic and ferromagnetic substances (ii) hard magnetic materials and soft magnetic materials. (2+2)