Code : 221201

B.Tech 2nd Semester Exam., 2015

PHYSICS

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

1. Answer any *seven* of the following questions : 2×7=14

(a) Prove that the given vector $\vec{A}$ is solenoidal vector, where

$$\vec{A} = 3y^2z^2\hat{i} + 3x^2z^2\hat{j} + 3x^2y^2\hat{k}$$

(b) Calculate the value of Poynting vector at the surface of the sun if the power radiated by the sun is 4×10^{26} W and its radius is 7×10^{8} m.

(c) Prove the nonexistence of isolated magnetic poles.

(d) Calculate the relative population of sodium atoms in a sodium lamp of wavelength 590 nm in the first excited state and in the ground state at a temperature 300 °C.

(e) What are the characteristics of a laser?

(f) Determine the de Broglie wavelength of a ball of mass 0·050 kg moving at 1 m/s.

(g) What are the assumptions of Planck's quantum theory?

(h) Define dielectric constant and polarization.

(i) The refractive index of water is 1·33. Calculate the polarizing angle for water.

(j) How many cubes of 1 nm on each side can be curved out of a cube 1 m on each side?

2. Derive Lorentz transformation equations and using them derive expression for length contraction and time dilation. Show that

$$x'^2 - c^2t'^2 = x^2 - c^2t^2$$ 6+3+3+2=14

3. *(a)* What are the different transition processes involved with lasing action? 5

(b) What is population inversion? Explain. 5

(c) Find the energy difference between the two energy levels of neon atoms of a He-Ne gas laser. 4

4. Discuss the principle, construction and action of a Nicol prism. Calculate the velocities of ordinary and extraordinary rays in calcite crystal in a plane perpendicular to the optic axis. The refractive indices of calcite crystal for E-ray and O-ray are 1·485 and 1·659 respectively. 2+3+6+3=14

5. *(a)* Obtain the expression for stationary energy levels for particle of mass m which is free to move in a region of zero potential between two rigid walls at $x=0$ and $x=4$. Are the energy levels degenerate? 8+2=10

   (b) Evaluate the expectation value $\langle x \rangle$ for a one-dimensional potential box of length L in the ground state. 4

6. *(a)* State Maxwell's equation in integral form. 6

   (b) Obtain an expression for the speed of propagation of the plane e.m. wave in terms of permittivity and permeability of the medium. 8

7. *(a)* Derive the relation $\vec{D} = \varepsilon_0 \vec{E} + \vec{P}$, where the terms have their usual meanings. 7

   (b) Prove that the tangential component of the electric field intensity vector and the normal component of the electric displacement vector are continuous across the boundary between two different dielectric media. 7

8. *(a)* State and explain Einstein's equation for explaining photoelectric emission. 2+6=8

   (b) Why does the unmodified line appear in Compton scattering? 6

9. Write short notes on any *two* of the following : 7×2=14

   (a) Displacement current

   (b) Galilean transformation

   (c) Spatial coherence

   (d) Sol-gel technique

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