Code : 221201

B.Tech 2nd Semester Exam., 2018

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* questions of the following : 2×7=14

(a) Write down Gauss law.

(b) Explain the conservative nature of electric field.

(c) Draw the energy level diagram for a gas laser.

(d) Find out resolving power of a grating.

(e) Write a short note on electro-optic effect.

(f) Briefly explain wave particle duality.

(g) Briefly describe the Davisson-Germer experiment.

(h) Explain briefly the concept of operators in wave mechanics.

(i) Write down the Lorentz transformation equations in relativity.

(j) Briefly explain the importance of surface to volume ratio in nanotechnology.

2. *(a)* Derive an expression for the electrostatic energy density. 4

(b) Derive the boundary conditions for D and H at the interface of two dielectrics; hence prove Snell's laws of electrostatics. 5

(c) A point charge of 5 nC is located at the origin. If $V = 2$ V at (0, 6, −8), find *(i)* the potential at A (−3, 2, 6) and *(ii)* the potential difference V_{AB}. 5

3. *(a)* What do you mean by displacement current? Show that the conduction current in the connecting leads of a capacitor is equal to the displacement current between its plates. 4

(b) Starting with Maxwell's equations, derive Poynting theorem. 5

(c) Calculate the skin depth δ and the wave velocity at a frequency of 1·6 MHz in aluminium for which $\sigma = 38 \cdot 2$ MS/m and $\mu_r = 1$. 5

4. *(a)* Explain the concept of temporal and spatial coherence. 4

(b) What do you mean by stimulated emission? Derive the relation between Einstein's A and B coefficients. 5

(c) Explain the working of a solid state laser. 5

5. *(a)* What is the difference among linearly polarized, circularly polarized and unpolarized light? 3

(b) A glass plate is used as a polariser. Find the angle of polarization and the angle of refraction. Given μ for glass = 1·46. 3

(c) Derive the intensity distribution and positions of maxima and minima for diffraction through a single slit. 8

6. *(a)* What do you mean by UV catastrophe? Show that the law of Planck merges with Rayleigh-Jeans at low frequencies. 4

(b) X-rays of wavelength 10 pm are scattered from a target. Find *(i)* the wavelength of the X-rays scattered through 45°; *(ii)* the maximum wavelength present in the scattered X-rays; *(iii)* the maximum kinetic energy of the recoil electron. 6

(c) An electron is confined to a box of length 10^{-9} m, calculate the minimum uncertainty in its velocity. Given, mass of the electron $m = 9 \times 10^{-31}$ kg and $h = 6 \cdot 6 \times 10^{-34}$ J-s. 4

7. *(a)* Set up Schrodinger's equation for a particle trapped in a box. Solve the equation and normalize the wavefunction. Discuss the physical interpretation of the obtained energy eigenvalues. 10

(b) Find the probability that a particle trapped in a box L wide can be found between 0·45 L and 0·55 L for the ground and first excited states. 4

8. *(a)* Write down the postulates of special theory of relativity. 2

(b) What do you mean by time dilation and length contraction? 3

(c) An electron ($m = 0 \cdot 511$ MeV/c^2) and a photon ($m = 0$) both have momenta of 2 MeV/c. Find the total energy of each. 4

(d) Deduce the fractional increase of mass of a particle for velocity 0·1 c. 5

9. Write notes on the following : 4+5+5=14

(a) Top-down and bottom-up techniques

(b) Blue shift in semiconducting nanostructures

(c) Applications of nanotechnology in the field of medicine and diagnostics

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