

Code : 221201

B.Tech 2nd Semester Examination, 2017

Physics

Time : 3 hours

Full Marks : 70

Instructions :

- (i) There are Nine Questions in this Paper.
 - (ii) Attempt Five questions in all.
 - (iii) Question No. 1 is Compulsory.
 - (iv) The marks are indicated in the right-hand margin.
1. (a) Write down Gauss law. 2×7
 - (b) What is Poynting theorem?
 - (c) Draw the energy level diagram for He-Ne laser.
 - (d) What do you mean by Rayleigh criterion?
 - (e) Write a short note on magneto-elastic effect.
 - (f) Briefly explain Einstein's photoelectric equation.
 - (g) Briefly describe the Davisson-Germer experiment.
 - (h) Explain briefly the concept of tunnelling in wave mechanics.
 - (i) Write down the Lorentz transformation equations in relativity.
 - (j) Briefly explain the importance of surface to volume ratio in nanotechnology.

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2. (a) Prove that $D = \epsilon_0 E + P$ 5
 - (b) Derive the boundary conditions for D and H at the interface of two dielectrics; hence prove Snell's laws of electrostatics. 5
 - (c) It is found that $E = 60a_x + 20a_y - 30a_z$ mV/m at a particular point on the interface between air and a conducting surface. Find D at that point. 4
3. (a) Write down the generalized forms of Maxwell's equations and discuss their physical interpretations. 4
 - (b) Using Maxwell's equations show that light is an electromagnetic wave. 4
 - (c) Calculate the skin depth δ and the wave velocity at a frequency of 1.6 MHz in aluminium for which $\sigma = 38.2$ MS/m and $\mu_r = 1$. 6
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 between polarised and unpolarised light? 2
 - (b) A glass plate is used as a polariser. Find the angle of polarisation and the angle of refraction. Given μ for glass = 1.54. 3

- (c) Two Nicol prisms are crossed to each other. Now one of them is rotated through 60° . What percentage of incident polarised light will pass through the system? Explain your answer. 4
- (d) Explain the principle of birefringence. Explain how birefringence can be used to calculate the stress in a material. 5
6. (a) What do you mean by UV catastrophe? Show that Planck's law merges with the Rayleigh Jeans at low frequencies. 4
- (b) Derive the wavelength shift for a photon in a Compton scattering process. 5
- (c) Determine the size of hydrogen atom using uncertainty principle. Give that potential energy $V = \frac{-e^2}{4\pi\epsilon_0 a}$ where a is the distance of the electron from the nucleus. 5
7. (a) Set up the Schrodinger's equation for a particle trapped in a box. Solve the equations and normalize the wave function. Discuss the physical interpretation of the obtained energy eigenvalues. 10
- (b) A particle limited to the x-axis has the wavefunction $\psi = ax$ between $x = 0$ and $x = 1$; $\psi = 0$ elsewhere. Find the probability that the particle can be found between

$x = 0.45$ and $x = 0.55$. Also find the expectation value $\langle x \rangle$ of the particle's position. 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) A spacecraft is moving relative to earth. An observer on the earth finds that, between 1 PM and 2 PM according to her clock, 3601 s elapse on the spacecraft's clock. What is the spacecraft's speed relative to earth? 4
- (d) A stationary body explodes into two fragments each of mass 1.0 kg that move apart at speeds of $0.6c$ relative to the original body. Find the mass of the original body. Explain the interpretation of your answer. 5
9. Write short notes on:
- (a) Tops down and bottoms-up technique 4
- (b) Quantum confinement in semiconducting nanostructures 5
- (c) Applications of nanotechnology in the field of medicine and therapy

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