

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

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2. (a) Prove that  $D = \epsilon_0 E + P$  akubihar.com 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. akubihar.com 4  
 (c) Calculate the skin depth  $\delta$  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? akubihar.com 2  
 (b) A glass plate is used as a polariser. Find the angle of polarisation and the angle of refraction. Given  $\mu$  for glass = 1.54. 3

- (c) Two Nicol prisms are crossed to each other. Now one of them is rotated through  $60^\circ$ . 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. akubihar.com 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? akubihar.com 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: akubihar.com
- (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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