

B. INFORMATION 1ST. YEAR 1ST. SEM. EXAM. – 2018

PHYSICS – IA

Time: 3 hours

Full Marks: 100

Answer any five questions.

1. a) Write down the Schrodinger equation. When the probability density of the state is not function of time? Show this starting from the Schrodinger equation.
 b) Find the wave function of the particle confined under the potential $V(x) = 0$ for $0 < x < a$, and elsewhere $V(x) = \infty$.
 c) Plot i) wave function, and ii) probability density as a function of x .

2. a) Calculate the de Broglie wavelengths of an electron having kinetic energy 13.6 eV and an iron ball having mass 50 gm and velocity 50 m/s.
 b) Prove that $[\hat{x}, \hat{p}] = i\hbar$.
 c) Estimate the size of an atom using uncertainty principle assuming a bench mark value of the kinetic energy of the electron.
 d) Write down the postulates of quantum mechanics.

3. a) Write down the differential equation for a wave motion.
 b) What do you mean by temporal coherence?
 c) Distinguish different classes of diffraction.
 d) Find the intensity distribution for a single slit diffraction experiment. Then, find the position of the maximum intensities.
 e) Derive the radius of n -th dark ring in Newton ring experiment.

4. a) Show that the small fluctuation of a system from the stable minimum of a potential generates a simple harmonic motion.
 b) Write down the equation of motion of a simple harmonic oscillator with and without damping force.
 c) Solve it and draw x vs. t diagram for all cases.

5. a) Derive an expression for current when a.c. voltage is applied to a series LCR circuit with the help of the phasor-diagram.
 b) What do you mean by resonance in series LCR circuit? Find an expression for the Q factor for the above circuit.
 c) Derive an expression for capacitance of a cylindrical capacitor with inner radius a and outer radius b and having surface charge density σ .
 d) What is the electrostatic energy stored in a parallel plate capacitor

6. a) Show how a vector undergoes transformation under rotation of coordinate system. b) What do you mean by gradient of a scalar function? Evaluate the gradient on the surface $yz - 4xyz^2 = -6$ at $(1,2,1)$.
- c) Prove $\vec{\nabla} \cdot (f\vec{A}) = (\vec{\nabla}f) \cdot \vec{A} + f\vec{\nabla} \cdot \vec{A}$
- d) Calculate $\vec{\nabla} \left(\frac{1}{r} \right)$.
7. a) State and explain briefly the first law of thermodynamics.
- b) Show that the total internal energy of the universe is constant.
- c) Why internal energy remains constant during isothermal expansion of an ideal gas?
- d) What do you mean by state function of a system? Write and explain all the statements of the second law of thermodynamics.
- e) Show diagrammatically the different steps of a Carnot engine and Carnot refrigerator. Then define efficiency of a Carnot engine in terms heat energy from the carnot cycle.