PART-I(MCQS): MAXIMUM 30 MINUTES | PART-II | MAXIMUM MARKS = 80

NOTE: (i) **Part-II** is to be attempted on the separate **Answer Book.**
(ii) Attempt **ONLY FOUR** questions from **PART-II. ALL** questions carry **EQUAL** marks.
(iii) All the parts (if any) of each Question must be attempted at one place instead of at different places.
(iv) Write Q. No. in the Answer Book in accordance with Q. No. in the Q.Paper.
(v) No Page/Space be left blank between the answers. All the blank pages of Answer Book must be crossed.
(vi) Extra attempt of any question or any part of the question will not be considered.
(vii) **Use of Calculator is allowed.**

PART – II

Q. 2. A particle of mass m is in the state

$$\psi(x,t) = A\, e^{-a\left[\left(\frac{mx^2}{\hbar}\right)+it\right]}$$

Where A and a are positive constants.

(a) Find A. (5)
(b) For what potential energy function V(x) does $\psi(x,t)$ satisfy the Schrodinger equation? (5)
(c) Calculate the expectation values of x, x^2, p, and p^2 (5)
(d) Find σ_x and σ_y. Is their product consistent with the uncertainty principle? (5) **(20)**

Q. 3. **(a)** Consider a pair of copper wires 1 mm in diameter and 5 cm apart. In copper the number of conduction electrons per cubic meter is 8.45×10^{28}. Suppose their mean drift velocity v is 0.3 cm / s, calculate current in each wire. (8)
(b) If the wires are 20 cm apart, calculate the magnetic force on the wires. (8)
(c) Define electric current in a wire with respect to number of charges and their drift velocity. (4) **(20)**

Q. 4. Give expressions for the following quantities in terms of e, h, c, k, m_e and m_p.
(a) The energy needed to ionize a hydrogen atom. (5)
(b) The difference in frequency of the Lyman alpha line in hydrogen and deuterium atoms. (5)
(c) The magnetic moment of the electron. (5)
(d) The spread in measurement of the π^0 mass, given that the π^0 lifetime is τ. (5) **(20)**

Q. 5. **(a)** An atom is capable of existing in two states: a ground state of mass M and an excited state of mass $M + \Delta$. If the transition from ground to excited state proceeds by the absorption of a photon, what must be the photon frequency in the laboratory where the atom is initially at rest? (7)
(b) Derive the energy levels of the hydrogen atom, from Coulomb's law and the simple quantization of angular momentum. (7)
(c) In radio astronomy, hydrogen atoms are observed in which, for example, radiative transitions from n = 109 to n = 108 occur. What are the frequency and wavelength of the radiation emitted in this transition? (6) **(20)**

Q. 6. **(a)** Consider the elastic vibrations of a crystal with one atom in the primitive cell and calculate the frequency of an elastic wave in terms of the wavevector that describes the wave and in terms of the elastic constants. (12)
(b) Describe vibrations of crystal. (8) **(20)**

Q. 7. **(a)** Discuss density of states in Three Dimension (8)
(8)