

(i) Printed Pages : 3

Roll No.

(ii) Questions : 7

Sub. Code :

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Exam. Code :

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B.A./B.Sc. (General) 3rd Semester

1125

PHYSICS

Paper : C – Quantum Physics

Time Allowed : 3 Hours]

[Maximum Marks : 22

Note :- (1) Attempt **five** questions in all, selecting at least **two** questions each from Unit-I and Unit-II. Question No. 7 of Unit-III is compulsory.

(2) Use of non-programmable calculator is allowed.

UNIT-I

1. (a) Define Uncertainty principle. Give any two applications of this principle. 2

(b) A particle is described by a wave function $\Psi(x) = \frac{1+ix}{1+ix^2}$,

prove that average value of position of the particle is zero.

2

2. (a) Show that $m \frac{d}{dt} \langle x \rangle = \langle p_x \rangle$ [Ehrenfest theorem]. 2

(b) Show that $e^{i\phi}$ is an eigen function of z component of angular momentum operator. 2

3. (a) Show that if Ψ_1 and Ψ_2 are the solutions of time independent Schrodinger equation, then the function $\Psi = C_1\Psi_1 + C_2\Psi_2$ is also a solution for any constants C_1 and C_2 . 2
- (b) Show that group velocity V_g can be obtained from phase velocity V_p by the relation :

$$V_g = V_p - \lambda \frac{dV_p}{d\lambda}, \lambda \text{ is wavelength.} \quad 2$$

UNIT-II

4. What do you mean by Tunnel effect ? A particle travelling with Energy E along x -axis faces a potential barrier defined as :

$$V(x) = \begin{cases} 0 & \text{for } x < 0 \\ V_0 & \text{for } 0 < x < a \\ 0 & \text{for } x > a \end{cases}$$

Derive an expression for transmission coefficient of the barrier.

4

5. (a) The ground state wave function for hydrogen atom is

$$\Psi = \frac{1}{\sqrt{\pi a_0^3}} e^{-\frac{r}{a_0}}, \text{ find the value of average distance of the}$$

electron from the nucleus. 2

- (b) Show that the state of a hydrogen atom for a given value of n is n^2 fold degenerate. 2

6. (a) For a free particle trapped in a one dimensional box, show the plots of normalised wave function and probability density.

2

- (b) What are nodes and antinodes ? Where do they occur ? Explain in terms of probability density. [Related to part(a)].

2

UNIT-III

7. Attempt any **six** parts :

- (a) Show that operators p_x and p_y commute.
- (b) What is the zero point energy of harmonic oscillator ?
- (c) Explain the term degeneracy.
- (d) What are the orthonormal functions ?
- (e) Show that sum of reflection and transmission coefficients for a potential barrier for $E > V_0$ is unity, E is total energy. V_0 is height of barrier.
- (f) Show that momentum operator is a Hermitian operator.
- (g) Define Gaussian wave packets.

1×6=6