

**C158**

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# **MSCPH-503**

## **Quantum Mechanics**

M.Sc. PHYSICS (MSCPH-21)

1st Semester Examination, 2022 (June)

**Time : 2 Hours]**

**Max. Marks : 80**

**Note :** This paper is of Eighty (80) marks divided into two (02) Sections A and B. Attempt the questions contained in these sections according to the detailed instructions given therein.

### **SECTION–A**

#### **(Long Answer Type Questions)**

**Note :** Section 'A' contains Five (05) long answer type questions of Twenty (20) marks each. Learners are required to answer any Two (02) questions only.

(2×20=40)

1. Using the Bohr model, find the speed, the radius, and the energy of the system in the case of circular orbits. Determine also the angular frequency of the radiation generated by a transition of the system from an energy state  $n$  to  $m$ .

2. Consider a hydrogen atom which is in its ground state: the ground state wave function is given by

$$\psi(r, \theta, \phi) = \frac{1}{\sqrt{\pi a_0^3}} e^{-r/a_0}$$

where  $a_0$  is the Bohr radius.

- (a) Find the most probable distance between the electron and the proton when hydrogen atom is in its ground state.
- (b) Find the average distance between the electron and the proton.
3. What do you mean by perturbation theory? Discuss the perturbation theory for non-degenerate levels in first orders.
4. Show that Pauli matrices are all traceless, square of each of them is unity and all of them are mutually anti-commuting.
5. Determine the Eigen function of angular momentum operator obtained by adding two orbital angular momenta  $L_1$  and  $L_2$ .

## SECTION-B

### (Short Answer Type Questions)

**Note :** Section 'B' contains Eight (08) short answer type questions of Ten (10) marks each. Learners are required to answer any Four (04) questions only. (4×10=40)

1. Discuss the Einstein's explanation of photoelectric effect. State the laws of photoelectric emission.
2. Write down two expressions of the uncertainty principle. Discuss the wave nature of matter and obtain an expression of de Broglie wavelength for matter waves.
3. Using Schrodinger's equation discuss and solve the problem of particle in a 3D box.
4. Obtain ground state wave function for hydrogen atom and calculate the most probable distance of the electron from the nucleus.
5. What is Hermitian operator? Show that Hermitian operators have real Eigen values. Also define (a) linear operator, (b) projection operator and (c) unitary operator.
6. Give the theory of Born approximation in scattering.

7. Describe W.K.B. approximation method and give an application of this method.
  8. What do you mean by Zeeman Effect? Explain the theory of 1st order and 2nd order Zeeman Effect.
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