UG (CBCS) IIIrd Year Annual Examination

3000

B.Sc. PHYSICS

(Quantum Mechanics)

(DSE-1B)

Paper : PHYS 305 TH

Time : 3 Hours]   [Maximum Marks : 50

Note :– Attempt *five* questions in all, selecting *one* question from each of the Sections–B, C, D and E respectively. Question No. 1 (Section–A) is compulsory.

Section–A

(Compulsory Question)

1. (i)   What are Eigen values and Eigen functions ?

    (ii) What is Hamiltonian operator ?

    (iii) Why a particle in a box cannot have zero energy quantum mechanically ?

(iv) Name the three quantum numbers n, I and m_I with their permissible values.

(v) Calculate Lande's 'g' factor for s-electron.

(vi) What is Fine Structure ? What is its cause ?

(vii) Differentiate between symmetric and anti-symmetric wave functions. 2×7=14

Section–B

2. (a) Obtain time dependent Schrödinger's wave equation for a free particle and for a particle sujected to a force.

(b) A particle is moving in a one-dimensional box and its wave function is given by :

$$\psi_n(x) = A \sin\left(\frac{n\pi x}{a}\right)$$

Find the expression for the normalized wave function. 6,3

3. (a) Using uncertainty principle :

(i) Explain the existence of zero point energy.

(ii) Calculate the minimum energy of harmonic oscillator.

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(b) Write a short note on Fourier transforms of a pulse and wave group.

6,3

Section–C

4. Write Schrödinger equation for a particle in a box and determine expressions for the energy eigen values and eigen functions.

9

5. What is Harmonic Oscillator ? Calculate its zero point energy.

9

Section–D

6. Derive time independent Schrödinger equation in spherical polar coordinates.

9

7. (a) Describe Stern Gerlach experiment with necessary theory. Give the aim and discuss the significance of the experiment.

(b) Calculate the total angular momentum vector and represent their orbital states when $n = 2$ and $s = 1/2$.

7,2

Section–E

8. What is normal Zeeman effect ? Explain it with necessary theory and derive expression for Zeeman shift.

   9

9. (a) Discuss L-S and J-J coupling schemes.

   (b) Find S, L and J values that correspond to each of the following states :

   7,2

   $$^2D_{3/2} \text{ and } ^5F_5.$$