End Semester Examination, 2022

Semester - V

Physics

PAPER - CC-11T

Full Marks : 40

Time : 2 Hours

The Figures in the right hand margin indicate marks. Candidates are required to give their answers in their own words as far as practicable.

Group - A

1. *Answer any <u>five</u> of the following :*

a) What do you mean by 'wave function' and 'probability density' ? 2

b) Can all three components of angular momentum be measured with absolute precision at the same time ? 2

c) Determine the eignvalue and eigenfunction of the operator $x + \frac{d}{dx}$. 2

d) Show that the degeneracy of the energy level E_n of hydrogen atom for principal quantum number n is n^2. 2

e) Draw the wave function for the first excited state of linear harmonic oscillator and explain its parity. 2

f) Find out the magnitude of the magnetic moment of $2p_{3/2}$ state where 1 Bohr magneton is given by 9.27×10^{-24} J/T. 2

g) Determine the free particle eigenfunction by solving the eigenvalue equation. 2

h) Explain space quantization with an example. 2

Group - B

Answer any <u>four</u> of the following :

2. Dissociate the schrödinger equation of hydrogen atom in spherical co-ordinates into radial and angular parts by the method of separation of variable. 5

3. What are creation and anniliation operators of Linear harmonic oscillator ? Explain mathematically how they assume their names ? 2+3

4. Consider two operators A and B. They separately commute with their commutator i.e., [A, [A,B]] = 0 ad [B, [A, B]] = 0. Prove the identity

$$e^{A}e^{B} = exp[A+B+\tfrac{1}{2}[A,B]\,]$$ 5

5. Starting from the schrödinger equation, obtain the eigenvalues and eigenfunctions of the particle moving in the following potential 5

$$V = 0\ for\ |x| \le \frac{a}{2}$$

$$\neq \infty\ for\ |x| > \frac{a}{2}$$

6. Draw the fine structure energy levels for the transition from n=3 to n=2 of H_α line and specify the allowed transitions. 5

7. What do you mean by Hermitian operators ? Prove that the momentum and the Hamiltonian operators in one dimension are Hermitian. 1+4

Group - C

Answer any <u>one</u> of the following :

8. Explain anomalous Zeeman effect and draw the Zuman splitting of sodium D_1 and D_2 lines. What is Paschen-Back effect ? 5+3+2

9. a) Determine the probability of finding a linear harmonic oscillator within the classical turning points in its ground state.

   b) A beam of electrons is incident on an energy step of height 0.03 eV. Determine the fraction of electrons reflected and transmitted if the energy of the incident electrons is 0.04 eV. 5+5