Name: **Enrolment No:**	UPES UNIVERSITY OF THE FUTURE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2022

Course: Quantum Mechanics and Applications **Semester: V**
Course Code: PHYS3001
Programme: BSc Physics (H) **Max. Marks: 100**
Total pages: 2 **Time: 03 hrs.**

Instructions:

- All questions are compulsory (**Q8** and **Q11** have internal choice)

SECTION-A

S. No.		Marks	CO
Q1.	For a given wavefunction, $\psi = \sqrt{2/L}\, sin(\pi x/L)$, calculate probability between 0 to L/2 $(a)1, (b)\ 1/3, (c)1/2, (d)\ 1/5$ (choose correct one)	**4**	**CO1**
Q2.	Choose correct difference between energy Eigen values of 1D harmonic oscillator for (n+1)th and nth states, $(a)\frac{\hbar\omega}{2}, (b)2\hbar\omega, (c)3\hbar\omega, (d)\ \hbar\omega$.	**4**	**CO1**
Q3.	The correct commutator relation is $(a)[x, p_x] = i\hbar,\ (b)[L^2, L_x] = 0,\ (c)$both are correct, (d)none.	**4**	**CO2**
Q4.	Kinetic energy of an electron whose de-Broglie wavelength, λ = 0.1 nm is $(a)100\ eV,\ (b)150\ eV, (c)175\ eV\ , (d)200\ eV$.	**4**	**CO3**
Q5.	Lande g factor for the state $3\ ^2\boldsymbol{D}_{5/2}$ is (a) 2/3, (b) 6/5, (c) 5/3, (d) 4/3 (choose correct one).	**4**	**CO4**

SECTION-B

Q6.	Prove that Eigen values of Hermitian operators are real.	**10**	**CO1**
Q7.	Evaluate most probable position for the state, $\psi(x) = Nxe^{-(\alpha^2x^2/2)}$, where α = constant, and N = normalization constant.	**10**	**CO2**

Q8.	Write short note on (a) LS coupling **OR** (b) Paschen Back effect	**10**	**CO2**
Q9.	For a given wavefunction, $\Phi = Ae^{2i\varphi}$, where A = constant, Calculate Eigen value of L_z operator.	**10**	**CO3**
	SECTION-C		
Q10.	(a) What is spin-orbit interaction? Find the relation between **B** (magnetic field) and **L** (orbital angular momentum). (b) Discuss Stern-Gerlach experiment for space quantization.	**10** **10**	**CO3** **CO3**
Q11.	(a) Sketch Zeeman transition levels neatly for the atomic transition, 3d→2p. (b) What is space quantization? Calculate total angular momentum J and total magnetic moment μ_J for the state, $^2\boldsymbol{P}_{3/2}$ **OR** (a) Solve Schrodinger equation in spherical polar co-ordinates for radial part to obtain energy Eigen value of hydrogen atom of the form, $E_n = -\frac{me^4}{32\pi^2\varepsilon_0^2\hbar^2n^2}$ (b) Find average radius (<r>) the ground state of hydrogen atom, $\psi_{100}(r) = \frac{1}{\sqrt{\pi a_0^3}}e^{-r/a_0}$	**10** **10** **10** **10**	**CO4** **CO4** **CO4** **CO4**

Physical constants: $h = 6.63 \times 10^{-34}\ J-s,\ c = 3 \times 10^8\ m/s,\ a_0$ = Bohr radius = 0.53Å , $\mu_0 = 4\pi \times 10^{-7} H/m$, $\varepsilon_0 = 8.854 \times 10^{-12} F/m$, mass of proton= 1.6726 x 10^{-27} Kg, mass of electron= 9.1 x 10^{-31} Kg