Avinashilingam Institute for Home Science and Higher Education for Women
(Deemed to be University under Category 'A' by MHRD, Estd. u/s 3 of UGC Act 1956)
Re-accredited with A++ Grade by NAAC. Recognised by UGC Under Section 12B
Coimbatore - 641 043, Tamil Nadu, India

Continuous Internal Assessment – I (August 2025)
V Semester

Class: III B.Sc., **Duration: 2 hours**
Major: Physics **Max. Marks: 60 Marks**

23BPHC09 – Quantum Mechanics and Applications

Course Outcome:
1. Understand the quantum theory formulation through Schrodinger equation.
2. Understanding the behavior of quantum particle encountering a barrier potential
3. Applications of Schrodinger equation to hydrogen atom
4. Learn the concept of electric and magnetic fields on atoms and understand the Stark effect and Zeeman Effect respectively.
5. Understand the basic concepts of quantum many body problems

Part A **6x1 =6 Marks**

Answer all questions

1. $[x, \hat{p}_x^{101}] =$ CO1K2
   a. 100 iħ $\hat{p}_x^{101}$ b. 101 iħ $\hat{p}_x^{100}$ c. 99 iħ $\hat{p}_x^{101}$ d. 100 iħ $\hat{p}_x^{99}$
2. The operator for momentum $\hat{p}_x$ is CO1K2
   a. $-i\hbar\frac{d}{dx}$ b. $i\hbar\frac{d}{dx}$ c. $\hbar\frac{d}{dx}$ d. $-i\hbar\frac{d}{dy}$
3. Normalization is expressed as CO2K1
   a. $\int_{-\infty}^{\infty}\varphi^* x\varphi dx = 1$ b. $\int_{-\infty}^{\infty}\varphi^*\varphi dx = 1$ c. $\int_{-\infty}^{\infty}\varphi^*\varphi dx = 0$ d. $\int_{-\infty}^{\infty}\varphi^* x\varphi dx = 0$
4. When the width of the one dimensional well decreases two times, then the ground state energy in ---------- times. CO2K1
   a. decreases two b. decreases four c. increases two d. increases four
5. What is the formula for calculating the spin angular momentum of an electron? CO4K1
   a. $L = s\times\hbar$ b. $L = \sqrt{l(l+1)}\times\hbar$ c. $L = \sqrt{s(s+1)}\times\hbar$ d. $L = s\times(l+1)\times\hbar$
6. Zeeman Effect could not be proved by _____ CO4K1
   a. Quantum Mechanics b. Bohr's Model c. Hamiltonian operator's d. L-S coupling

Part B **3 x 6 = 18 Marks**

Answer ALL questions

Each answer should not exceed 400 words or two pages

7a. Obtain the wave function for a free particle **OR** CO1K3
7b. List out the properties of wave function CO1K2
8a.Describe uncertainty principle and obtain the value of $[x, \hat{p}_x^2]$ **OR** CO2K3
8b. Distinguish between anomalous Zeeman effect and Paschen-Back effect CO2 K1
9a. State and explain Larmor's theorem and derive the expression for change in K.E **OR** CO4K1
9b. Describe the Stern-Gerlach experiment and indicate the importance of the results obtained. CO4K2

Part C **3 x 12 = 36 Marks**

Answer ALL questions

Each answer should not exceed 800 words or two pages

10a. Derive time dependent Schrodinger wave equation. **OR** CO1K2
10b. Obtain the expectation value of the momentum of a particle moving in one dimensional square well potential. CO1K2
11a. (i). Describe superposition principle
(ii). Derive an expression for probability and probability current density **OR** CO1K2
11b. Obtain energy eigen function and eigen values of a particle of mass m confined one directional motion inside the potential well of width a. CO2K2
12 a. Explain the space quantization in terms of orbital and spin angular momentum of electron. **OR** CO4K2
12b. Describe the experimental arrangement for studying the Zeeman effect. Use classical ideas to explain normal Zeeman effect. Show that the Zeeman shift $d\lambda = \pm\frac{Be\lambda^2}{4\pi mc}$ CO4K2

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No.of Copies: 16 **Staff in-Charge: Dr.V.Sasirekha, & Ms.V.Bhuvaneswari**