NATIONAL OPEN UNIVERSITY OF NIGERIA
PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA
FACULTY OF SCIENCES
DEPARTMENT OF PHYSICS
2024_2 EXAMINATION

COURSE CODE: **PHY 309**
COURSE TITLE: **QUANTUM MEHANICS I**
CREDIT UNIT: **3**
TIME ALLOWED: **3 HRS**
INSTRUCTION: **Answer question 1 and any other three questions**

1a. Define the following: **L**aw of Stefan-Boltzmann,Orthogonality and Orthonormality. **9marks**

1b. What is the wavelength associated with a photon of a light with the energy is 3.6×10^{-19} J? **7marks**

1c. Describe Planck's three experimental observations that explain the photoelectric effect. **9marks**

2a. Find the eigenvalues and corresponding eigenvectors of the matrices: $\begin{bmatrix} -1 & 2 \\ 2 & 2 \end{bmatrix}$ **8marks**

b. For the Hermitian matrix 2a, show that the Eigen functions can be normalized and that they are orthogonal. **7marks**

3a. State the Heisenberg Uncertainty Principle **4marks**

b. Determine whether the vectors (1, 2, 3), (2, 4, 4) and (3, 6, 5) are linearly dependent or independent. **11marks**

4a Define inner product and linear operator **3marks**

b. Calculate <p> for a quantum oscillator given that $\varphi(x) = \sqrt{\frac{2}{L}}\sin(\frac{2\pi x}{L})$ with n = 2, and 0 < x < L. **12marks**

5a. List the Bohr's postulates **4marks**

b. The wave function $\varphi(x,t) = \varphi_o e^{-i\omega t}$ satisfies the time independent Schrodinger equation of a free particle. Show that $\nabla^2\Psi + \frac{2m(E-V)}{\hbar^2}\Psi = 0$. **11marks**

6a Highlight the limitations of Wien's and Rayleigh-Jean's Laws **4marks**

b. Derive the Rayleigh-jean's law that state that; $E_\lambda = \frac{8\pi kT}{\lambda^4}$ **11marks**