COURSE CODE: PHY309
COURSE TITLE: QUANTUM MECHANICS I
CREDIT UNIT: 3
TIME ALLOWED: (3 HRS)
INSTRUCTION: *Answer question 1 and any other three questions*

1a.   i   Explain what you understand by scattering state of a particle   **4marks**
    ii   A particle of energy 4 eV approaches a potential step of height 2eV. Calculate the transmission and reflection coefficients.   **6marks**

1b.   An electron and a photon each have a wavelength of 1.00 nm. Find

    i.   their momentum
    ii.   the energy of the photon, and
    iii.   the kinetic energy of the electron.   **9marks**

1c   Show that the following are vector spaces over the indicated field:

    (i)   The set of real numbers over the field of real numbers.
    (ii)   The set of complex numbers over the field of real numbers   **6marks**

2a.   State Wien's displacement law and its limitation   **5marks**
b.   States four (4) limitations of Classical mechanics that lead to the introduction of quantum mechanics   **4 marks**
c.   Find the uncertainty in the position of an electron when the mass of an electron is 9.1×10^{-28} g and the uncertainty in velocity is equal to 2×10^{-3} cm/sec. **6marks**

3a.   What is the De Broglie hypothesis? and state its equation.   **3marks**
b.   A particle with energy1eV encounters a potential barrier of height 2eV and width 0.5nm. What is the approximate probability of tunneling through the barrier? **7marks**
c.   A beam of radiation of wavelength $\lambda = 2000\mathring{A}$ impinges on a metal. Calculate the kinetic energy K and the speed ν of the photoelectrons   **5marks**

4a.   Given the matrix $\begin{bmatrix} 2 & 1 \\ 5 & 1 \end{bmatrix}$, find the corresponding eigenvectors and eigenvalue   **8marks**
b.   For the Hermitian matrix 2a, show that the Eigen functions can be normalized and that they are orthogonal.   **7marks**

5a.   Define Hermitian Matrices and Unitary Matrices   **4marks**
b.   Determine whether the vectors (5,-2,4), (2, -3, 5) and (4, 5, -7) are linearly dependent or independent.   **11marks**

6a.   Define Photoelectric effect   **3marks**
b.   What is meant by a bound state? What are the necessary conditions for a particle to be in a bound state?   **4 marks**
c.   What key experiments revealed the inadequacies of classical mechanics? **8marks**