FYUGP/Sem-6/PY-CE1

2026

Physics (Core)

Paper Code : PY-CE-6314

Paper Name : Quantum Mechanics

Time : 2 hours ***Full Marks : 50***

The figures in the margin indicate full marks for the questions.

1. Answer the following questions : 1×4=4
   a) Name one experiment which demonstrated the wave nature of electrons?
   b) What does $|\psi|^2$ represent ?
   c) If the width of an infinite square well potential increases, then what happens to the energy levels ?
   d) State one difference between classical and quantum harmonic oscillator.
2. Answer the following questions : 2×3=6
   a) What is Compton scattering ? Write the expression for Compton wavelength shift.
   b) What are stationary states in a quantum system ?
   c) What are Hermitian operators ? Why are they important in quantum mechanics ?
3. Answer the following questions ***(any two)*** : 5×2=10
   a) What is photoelectric effect ? Mention the important features of the effect.
   b) Evaluate the significance of the Davisson-Germer experiment in confirming the fundamental ideas of quantum mechanics.
   c) What do you understand by the wave function ψ of a moving particle ? Outline the physical significance of the wave function

Contd..

(ψ). A particle moving along the x-axis in the region $0 \le x \le a$ is represented by the wave function

$\psi(x) = A\sin\left(\frac{n\pi x}{a}\right)$ where n is an integer. Normalise the wave function. 1+1+3=5

d) Using the uncertainty principle, estimate the minimum kinetic energy of an electron confined within a region of size 10^{-10} m.

4. Answer the following questions *(any three)* : 10×3=30

a) State and explain Heisenberg's uncertainty principle. Derive the uncertainty relation between position and momentum and discuss its physical implications. 3+6+1=10

b) What do you mean by quantum tunnelling? Describe the phenomenon of quantum tunneling through a finite potential barrier. 2+8=10

c) Solve the Schrodinger equation for a particle confined in a one-dimensional infinite potential well and obtain the normalised eigenfunctions and energy eigenvalues. 6+2+2=10

d) Solve the time-independent Schrodinger equation for a one-dimensional quantum simple harmonic oscillator and obtain its energy eigenvalues. 10

e) i) What is an operator ? Write down the expression for position operator, momentum operator and energy operator. 2+3=5

ii) Using Uncertainty relation, show that an electron cannot exist inside a nucleus. 5

f) i) Derive and discuss the continuity equation in Quantum Mechanics using time dependent schrodinger equation. Determine the probability current density for the wave function-

$\psi(x) = a\,e^{-(\alpha^2 x^2)/2}\,e^{ikx}$ 6+4=10

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