



Continuous Assessment Test (CAT - II), December 2022

Programme	: B.Tech	Semester	: Fall 2022-2023
Course Title	: Engineering Physics	Course Code	: BPHY101L
School	: School of Advanced Sciences	Slot	: B1+TB1
Duration	: 90 mins	Max. Marks	: 50
Class No	: 2684, 5663, 5675, 5683, 5707		

Part - A (5 x 10 = 50)

Answer ALL Questions

Sl. No	Questions	Max Marks
1	What is the de-Broglie hypothesis for the matter waves (1+1 marks)? Identify (1 mark) and explain the experiment and its results (2 marks), which proved the de-Broglie hypothesis with the help of appropriate diagrams (3 marks) and formulas (1+1 marks).	10
2	Write the time-dependent Schrodinger wave equation (SWE) and define its components (2 marks). Starting from the plane-wave expression $\psi(x, t) = A \exp [i(kx - \omega t)]$, verify the time-dependent Schrodinger wave equation (7 marks). Explain why verifying the SWE with the plane wave function is sufficient (1 mark).	10
3	(a) Describe Heisenberg's uncertainty principle (2 marks). Then, examine the consequences by considering a macroscopic object (Example: Cricket ball) if the Planck constant becomes $h=6.63 \text{ J. sec}$ (3 marks). (b) In Compton scattering, an X-ray beam of wavelength 0.01nm is scattered from a nickel target, (i) Estimate the wavelength of the scattered X-ray at 60 degrees. (1 mark) (ii) Estimate the wavelength present in the back scattered X-rays. (2 mark) (iii) Estimate the maximum kinetic energy of the recoiled electron. (2 mark)	5 5
4	An electron is bound within a potential well with potential $U(x) = \begin{cases} 0, & 0 \leq x \leq \frac{L}{2} \\ \infty, & \text{elsewhere} \end{cases}$. Stating the reason, start with the appropriate Schrodinger wave equation (1 mark), and evaluate the eigenfunction and eigenvalues for the system (6 marks). Plot the wave function and probability density with energy value for the first excited state (1+1+1 marks).	10
5	(a) Define quantum confinement (1 mark), and classify the nanostructure based on this principle, discuss the effect on the density of states if the dimensions of a material are reduced to the nanoscale. Draw the appropriate energy band diagrams (2+2 marks). (b) An electron in an infinitely deep square well of length $L/2$, has associated matter wave function as $\Psi(x) = A \cos\left(\frac{2\pi x}{L}\right)$ for $-\frac{L}{4} \leq x \leq \frac{L}{4}$, and zero outside. Explain why outside the matter wave function should be zero (2 marks), and Calculate the normalization constant A (3 marks).	

