

Continuous Assessment Test (CAT - II), December 2022

Programme	: B.Tech.	Semester	: FALL 2022-23
Course Title	: Engineering Physics	Course Code	: BPHY101L
School	: School of Advanced Sciences	Slot	: B2+TB2
Duration	: 90 mins	Max. Marks	: 50
Class No	: 2685, 5666, 5678, 5686		

Part - A (5 x 10 = 50)

Answer ALL Questions

Sl. No	Questions	Max Marks
1	What is an ultraviolet catastrophe? Explain how Planck resolved the issue. Write the expression of Planck's radiation formula for the energy distribution of a blackbody in the frequency range and then deduce Planck's law in terms of wavelength. Determine the frequency ranges in which Planck's radiation law matches Wiens's exponential and Rayleigh-Jeans law. (2 + 2 + 1 + 3 + 2 marks)	10
2	Write the time-dependent Schrodinger wave equation. and define its components. What is the significance of the time-dependent Schrodinger wave equation in quantum mechanics? A classical wave is defined as $\psi(x, t) = A \sin(kx - \omega t + \phi)$, where k is the wave number, ω is the angular frequency and ϕ is a phase constant, and the wave is moving in the positive x-direction. Then show that the given wave is not a valid solution to the time-dependent Schrodinger wave equation. (1 + 2 + 1 + 6 marks)	10
3	a) Apply the quantum theory of light to explain the Compton effect. Evaluate if the visible light rays can show the Compton effect. Support your answer with a valid reason. (3 + 2 marks) b) A certain excited state of a hydrogen atom is known to have a lifetime of 2.5×10^{-14} s. Then, calculate the minimum error with which the energy of the excited state can be measured. (5 marks)	10
4	An electron of mass, m, is bound within a potential well with the given potential of: $V(x) = \begin{cases} 0, & 0 \leq x \leq \frac{L}{2} \\ \infty, & \text{elsewhere} \end{cases}$ Evaluate the energy, wave function, and probability density of the electron confined in this one-dimensional potential box. Plot the electron's corresponding Energy, Wave-function, and Probability Distribution inside the potential well for its 3 rd excitation state. (7 + 3 marks)	10
5	a. Briefly explain the construction, working principle, mode of operations, and two applications of the Scanning Tunnelling Microscope. (5 Marks) b. A nucleon inside the nucleus can be seen as a particle bound inside a 3D potential box. For such a case, if the cubical box size is 10^{-14} m, then compute the minimum energy (in eV) of a nucleon confined to the nucleus. (Given that the mass of the nucleon is = 1.6×10^{-27} kg) (5 Marks)	10

