



Course: Quantum Physics for Engineers	Improvement CIE	Marks: 50
Course code: 22PHY22C	Second semester 2022-2023 Physics Cycle: Computer Science Cluster	Time: 90 Minutes Date: 05.09.23

Instructions: Answer all questions.

Q No	PART B – Test	M	BT	CO
1a	Solve the problem of a particle in an infinite well to arrive at the un-normalized eigen function and eigen values.	7	3	1
1b	The 1 st excited state wave function of a particle in an infinite well is given by $\psi = B \sin(10^9 \pi x)$. Calculate B and energy of the state.	3	4	3
2a	Using Heisenberg's uncertainty principle, explain the broadening of atomic spectral lines. Hence derive an expression for the minimum line broadening.	7	2	1
2b	Calculate the difference in energy levels, given that the broadening of the emission line spectrum between them is 100Å and lifetime of the higher energy level is 100 μs.	3	3	3
3a	State de-Broglie's hypothesis. Use the expression relating momentum of a particle to the wavelength of its equivalent wave to arrive at the expression for the energy of a particle of mass m in the ground state of an infinite well of width a.	7	2	2
3b	An infinite well between 0 to a is shifted to the new position -0.5a to 0.5a. Will the eigenvalues and eigenfunctions change for this new configuration? Explain why.	3	4	3
4a	State the condition of unitarity of a matrix. Show that the Pauli Matrices σ_x , σ_y , σ_z are unitary matrices.	7	2	1
4b	Prove that the matrix given below is a unitary matrix. All intermediate steps need to be shown explicitly. $\begin{pmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ i & -i \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{pmatrix}$	3	3	3
5a	With a neat labelled diagram involving a single photon source, two beam splitters, two mirrors and two detectors, prove that a single photon simultaneously travels through both the paths at the same time and does not choose any one of the paths in a random fashion.	7	3	2
5b	Calculate the inner product between two vectors $ \psi\rangle$ and $ \chi\rangle$, given that for a particular basis, the two kets can be written as: $ \psi\rangle = 0.707 \phi_1\rangle + 0.707 \phi_2\rangle$ and $ \chi\rangle = 0.5 \phi_1\rangle + 0.866 \phi_2\rangle$.	3	4	4

COs	CO 1	CO 2	CO 3
Marks	21	14	15