U/K/TY

Reg. No:

Final Assessment Test – November 2025

VIT
Vellore Institute of Technology

Course: BAPHY105 - Engineering Physics

Class NBR(s): 5325 / 5339 / 5345 / 5394 / 5402 / 5405 / 5414

Slot: C1+TC1

Time: Three Hours

Max. Marks: 100

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

COs	CO Statements
CO1	Identify limitations of classical physics through experimental observations.
CO2	Apply matrix algebra and Dirac notation for the understanding of quantum mechanical problems involving linear operators, eigenvalues and eigenvectors.
CO3	Solve the particle in 1-D and 3-D potential box problem using the principles of quantum mechanics.
CO4	Apply fundamental concepts of quantum states and operators to understand the principles of quantum computing.

BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

Answer ALL Questions
(10 X 10 = 100 Marks)

1.	Discuss how classical Physics failed to explain the blackbody radiation. How did Planck's hypothesis resolve these issues? Validate it at low and high frequencies.	CO1	BL2
2.	Derive the condition for constructive and destructive interference in the double-slit experiment. How does the experiment prove the wave nature of light?	CO1	BL2
3.	Consider the following Kets, $\lvert\psi> = \begin{pmatrix} 5i \\ 2 \\ -i \end{pmatrix}$, $\lvert\phi> = \begin{pmatrix} 1 \\ 2i \\ -2i \end{pmatrix}$ (a) Check whether $\lvert\psi>$ and $\lvert\phi>$ are normalized or not. If not, normalize them. (b) Calculate the scalar product $<\psi\lvert\phi>$ and outer product $\lvert\psi><\phi\rvert$ of normalized Kets.	CO2	BL2
4.	Simplify the commutators: $[X, {P_x}^2]$ and $[X^2, P_x]$.	CO2	BL3
5.	Describe the sequence of measurements in the Stern Gerlach experiment when beams are passed successively through Stern Gerlach apparatus aligned along different axes (z, x, z). Explain the observed results and main conclusions.	CO3	BL2
6.	What is Schrödinger's equation and what is its importance? Obtain the time-independent Schrödinger wave equation.	CO3	BL2
7.	Derive the expressions for the energy eigenvalues and eigenfunctions of a particle of mass m confined in a one-dimensional infinite potential well of width L. Sketch the wave functions for the first three energy levels and interpret the physical significance of the results.	CO3	BL2
8.	Describe the phenomenon of quantum entanglement with a suitable example. Discuss how entangled states can be created experimentally in the laboratory, and outline some of its major applications in modern physics and technology.	CO4	BL2

9.a) i) Consider a state $|\psi\rangle = \frac{1}{\sqrt{2}}|\phi_1\rangle + \frac{1}{\sqrt{5}}|\phi_2\rangle + \frac{1}{\sqrt{10}}|\phi_3\rangle$ which is given in terms of three orthonormal eigenstate $|\phi_1\rangle$, $|\phi_2\rangle$ and $|\phi_3\rangle$ of an operator $\widehat{B}$ such that $\widehat{B}|\phi_n\rangle = n^2|\phi_n\rangle$. find the expectation value of $\widehat{B}$ for the state $|\psi\rangle$. CO3 BL3

ii) Calculate the tunneling probability for an electron of energy 5 eV approaching a barrier of height 10 eV and width 0.2 nm.

[OR]

9.b) i) Calculate the probability of finding the electron between $x = 0$ and $x = L/4$ of the box for $n = 1$.

ii) An electron is confined in an infinite potential box of length 2 Å. Calculate the frequency difference between the eighth and sixth excited states.

10.a) Write the mathematical representations of the Pauli X, Y and Z gates, and explain their operations on a general quantum state represented on the Bloch sphere. Illustrate the resulting transformations of the state vector under each gate. CO4 BL3

[OR]

10.b) i) What are Bell states? Describe their mathematical forms and discuss the key properties that make them maximally entangled states.

ii) Explain, with the help of a quantum circuit, how a Bell state can be generated using a Hadamard gate and a CNOT gate.

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