REG.NO.:

SLOT: C2+TC2

VIT

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF ADVANCED SCIENCES
CONTINUOUS ASSESSMENT TEST - II
WINTER SEMESTER 2025-2026

Programme Name & Branch	:	**B.Tech**
Course Code and Course Name	:	**BAPHY105, Engineering Physics**
Faculty Name(s)	:	**Prof. GOPAL, Prof. KRISHNAMOORTHI C, Prof. PREMKUMAR S, Prof. SAMUEL P, Prof. SARAVANAN R, Prof. SOUMYA CHAKRABARTI , Prof. UMMAL MOMEEN**
Class Number(s)	:	**VL2025260503654, 4783, 3656, 3660, 3664, 3657, 3667**
Date of Examination	:	**17-03-2026**
Exam Duration	:	**90 minutes**

Maximum Marks: 50

General instruction(s):

- Answer All Questions
- M - Max mark; CO – Course Outcome; BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)
- Course Outcomes (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.)

Q. No	Question	M	CO	BL
1.	Define a projection operator and state its properties. Consider the operator $P = \frac{1}{2}(I + \sigma_z)$, where I is 2x2 identity matrix and σ_z is the Pauli matrix. Show that P is a projection operator. Also determine the result of operating P on spin states $\|+z\rangle$ and $\|-z\rangle$, where $\|\pm z\rangle$ are the eigen vectors of σ_z.	10	2	BL2
2.	Consider the matrix $A=\begin{pmatrix} 2 & 1 & 0 \\ 1 & 2 & 0 \\ 0 & 0 & 5 \end{pmatrix}$. Check whether the matrix **A** is unitary. Find the eigenvalues and corresponding normalized eigenvectors of **A**.	10	2	BL3
3.	(a) For a particle with Hamiltonian $\hat{H} = \frac{\hat{p}^2}{2m} + V(\hat{x})$, evaluate the commutator $[\hat{x}, \hat{H}]$.	5	3	BL3
	(b) Consider the normalized wave function $\psi(x) = \sqrt{\frac{30}{L^5}}\, x(L-x),\ 0 \le x \le L.$ Given that the momentum operator is $\hat{p}_x = -i\hbar\frac{d}{dx}$, calculate the expectation value of $\hat{p}_x^2$.	5		
4.	(a) A beam of spin ½ particles initially prepared in the state $\|+z\rangle$ is passed through two Stern-Gerlach apparatus. In the first case the order of measurements is $S_x \rightarrow S_z$ while in the second case the order is $S_z \rightarrow S_x$. In both cases only the $+\hbar/2$ output beam is selected at each stage. Calculate the final fraction of particles in each case and comment on the result.	5	3	BL3
	(b) Obtain the equation governing the stationary state of a quantum mechanical system.	5		
5	A proton of mass m_p is confined in a 1D infinite potential well of length L. Derive the expression for energy eigenvalues E_n and the energy level spacing $\Delta E_n = E_{n+1} - E_n$. If the proton is replaced by a helium atom of mass $m_{He}=4m_p$, and box length is reduced to L/2, determine mathematically how the energy eigenvalues and the energy level spacing compare with those of the original system.	10	3	BL3