

**BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION)**

CLASS: IMSC
BRANCH: PHYSICS

SEMESTER: V
SESSION: MO/2022

SUBJECT: PH301 QUANTUM MECHANICS AND APPLICATIONS

TIME: 2 HOURS

FULL MARKS: 25

INSTRUCTIONS:

1. The total marks of the questions are 25.
2. Candidates attempt for all 25 marks.
3. Before attempting the question paper, be sure that you have got the correct question paper.
4. The missing data, if any, may be assumed suitably.
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

		CO	BL
Q1 (a) Discuss the physical significance of the wave function ψ ?	[2]	1	1
Q1 (b) Establish the time dependent Schrodinger equation	[3]	1,2	2
$\left(-\frac{\hbar^2}{2m} \nabla^2 + V \right) \psi = i\hbar \frac{\partial \psi}{\partial t}$			
Q2 (a) Discuss the conditions to be satisfied by an acceptable wave-function?	[2]	1	1
Q2 (b) A wave function $\psi(x) = A_n \sin \frac{2n\pi x}{L}$ in the region $0 \leq x \leq L$. Find the value of A_n using normalization condition?	[3]	1,2	3
Q3 (a) Explain what do you understand by the expectation value of a dynamical variable?	[2]	1	1,2
Q3 (b) Calculate the expectation value of p^2 for the wave function	[3]	2,3	3
$\psi(x) = \left(\frac{2}{L} \right)^{1/2} \sin \left(\frac{\pi x}{L} \right) \text{ in the region } 0 < x < L$ <p>and $\psi(x) = 0$ for $x > L$</p>			
Q4 (a) What do you understand by zero-point energy of a harmonic oscillator?	[2]	3	2
Q4 (b) For a potential step, show that there must be some reflection even if $E \gg V_0$?	[3]	2,3	3
Q5 (a) Explain the phenomenon of tunneling effect?	[2]	3	2
Q5 (b) For an alpha particle having $E = 1$ eV subjected to a thick rectangular potential barrier of height 2 eV calculate the probability of transmission? The expression for transmission coefficient for $E < V_0$ is given by	[3]	2,3	4,6
$T = \frac{-4 p_1^2 p_2^2 \sec^2 h^2(ip_2 a / \hbar)}{(p_1^2 + p_2^2)^2 \tanh^2(ip_2 a / \hbar) - 4 p_1^2 p_2^2}$ <p>(Use expression for a thick barrier $ip_2 a \gg \hbar$)</p>			