

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

CLASS: I.M.Sc
BRANCH: Physics

SEMESTER : V
SESSION : MO/2025

SUBJECT: PH301R1 QUANTUM MECHANICS AND APPLICATIONS

TIME: 02 Hours

FULL MARKS: 25

INSTRUCTIONS:

1. The question paper contains 5 questions each of 5 marks and total 25 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates

		CO	BL
Q.1(a) What do you understand by Wave-particle duality?	[2]	1	2
Q.1(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	4
Q.2(a) Calculate the wavelength associated with an electron subjected to a potential difference of 1.25 kV?	[2]	1	3
Q.2(b) Derive the wave function and energy eigenvalues for a square well potential given by $V=0$ in the range $x=0$ to $x=L$, and $V=\infty$ elsewhere.	[3]	2	2
Q.3(a) Discuss the conditions to be satisfied by an acceptable wave-function?	[2]		1
Q.3(b) Calculate the expectation value of p^2 for the wave function $\psi(x) = \left(\frac{2}{L}\right)^{1/2} \sin\left(\frac{\pi x}{L}\right)$ in the region $0 < x < L$ and $\psi(x) = 0$ for $ x > L$	[3]		4
Q.4(a) Write down the expression for momentum wave function for a free particle?	[2]		1
Q.4(b) Obtain the general form of Fourier transform and apply it to the wave function $f(x) = \frac{1}{\sqrt{\sigma\sqrt{\pi}}} e^{-x^2/2\sigma^2}$. Plot $f(x)$ and $F(k)$.	[3]		3
Q.5(a) Write down the time independent and time dependent Schrodinger equation?	[2]		1
Q.5(b) For a rectangular potential barrier of width a and height V_0 , show that the transmission co-efficient for $(E > V_0)$ can be expressed as $T = \frac{4p_1^2 p_2^2}{(p_1^2 - p_2^2)^2 \sin^2(p_2 a / \hbar) + 4p_1^2 p_2^2}$.	[3]		3

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