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

CLASS: I.MSc **SEMESTER: V**
BRANCH: PHYSICS **SESSION: MO/2024**

SUBJECT: PH301 QUANTUM MECHANICS AND APPLICATIONS (QMA)

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)	Calculate the wavelength associated with an electron subjected to a potential difference of 1.25 kV?	[3]	1,2	2
Q2	(a)	Discuss the conditions to be satisfied by an acceptable wave-function?	[2]	1	1
Q2	(b)	Establish the time dependent Schrodinger equation $\left(-\frac{\hbar^2}{2m}\nabla^2 + V\right)\psi = i\hbar\frac{\partial\psi}{\partial t}$	[3]	1,2	3
Q3	(a)	What do you understand by Wave-particle duality?	[2]	1	1,2
Q3	(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 $\psi(x) = 0 \; for \; \lvert x\rvert > L$	[3]	2,3	3
Q4	(a)	Write down the expression for momentum wave function for a free particle?	[2]	2	2
Q4	(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]	2	3
Q5	(a)	Write down the time-dependent Schrodinger equation?	[2]	2	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_o is given by $T = \frac{-4p_1^2p_2^2\sec h^2(ip_2a/\hbar)}{(p_1^2+p_2^2)^2\tanh^2(ip_2a/\hbar) - 4p_1^2p_2^2}$ (Use expression for a thick barrier $ip_2a >> \hbar$)	[3]	2,3	4,6

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