

COEP TECHNOLOGICAL UNIVERSITY (COEP Tech)

A Unitary Public University of Government of Maharashtra (Formerly College of Engineering Pune (COEP))



END Semester Examination

Programme: B. Tech.

Course Code: PH 23002

Branch: Computer Engg (FY Div8,9)

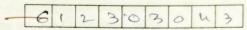
Duration: 3Hrs

Semester: II

Course Name: Quantum Physics

Academic Year: 2023-24

Max Marks: 60



Student PRN No. Instructions:

- 1. Figures to the right indicate the full marks.
- 2. Mobile phones and programmable calculators are strictly prohibited.
- 3. Writing anything on question paper is not allowed.
- 4. Exchange/Sharing of stationery, calculator etc. not allowed.
- 5. Write your PRN Number on Question Paper.

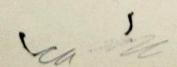
			Marks	co	PO
Q1/	A	Using the concept of wavepacket, derive the expression for Heisenberg's uncertainty principle.	4	1	
	(B)	Show that, for a "non-relativistic particle", group velocity is equal to particle velocity.	4	I	
	С	If the kinetic energy of electron is measured to be 1eV with an accuracy of 0.0001eV, what is the uncertainty in it's position? Given that, $(h/2\pi) = 1.054 \times 10^{-34} \text{J}$ sec, mass of electron = $9.1 \times 10^{-31} \text{Kg}$. (Use the uncertainty product of the order of $\hbar = h/2\pi$)	4	1	
Q2	A	Using the wavefunction of the particle derive Schrodinger's time dependent wave equation.	4	11	
	В	Apply the Schrodinger's wave equation to the harmonic oscillator problem and show that energy levels are quantized. Also sketch the energy levels.	4,	II	
1	(C)	Calculate the probability of transmission of alpha particle through the barrier of height 2eV. Given that, energy of particle is 1eV, mass of alpha particle is $6.4 \times 10^{-27} \text{Kg}$ and width of the barrier is 1 A.U., the value of $(h/2\pi) = 1.054 \times 10^{-34} \text{J}$ sec.	4.	11	
23	A	Show that for a Hermitian operator, all of its eigenvalues are real and the eigenvectors corresponding to different eigenvalues are orthogonal.	4	111	



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В	Show that the commutator of two Hermitian operators is anti-Hermitian.	2	III
C	A state Ψ⟩ is define as	4	111
	$ \Psi\rangle$ = $(1/\sqrt{2})$ $ \phi_1\rangle$ + $(-i/\sqrt{2})$ $ \phi_2\rangle$ where $\{ \phi_i\rangle\}$ are orthonormal bases.		
	Check if this state $ \Psi\rangle$ forms the projection operator? Determine the closure condition for the given state $ \Psi\rangle$		
D	Determine the eigen value of the operator \hat{O} having eigen function $g(x)$. The operator \hat{O} and the eigen function are as given below:	4	III Western
	$\widehat{O} = \left(-\frac{\partial^2}{\partial x^2} + x^2\right) \qquad g(x) = Axe^{\frac{-x^2}{2}}$		
E	For the given operators A and B,	4	III
	$A = \begin{pmatrix} 8 - 2i & 4i & 0 \\ 1 & 0 & 1 - i \\ -8 & i & 6i \end{pmatrix}, \qquad B = \begin{pmatrix} -i & 2 & 1 - i \\ 6 & 1 + i & 3i \\ 1 & 5 + 7i & 0 \end{pmatrix}$		
	Calculate Trace [A,B].		
	OR		
	Calculate A ⁻¹ , B ⁻¹ and check that (A B) ⁻¹ = B ⁻¹ A ⁻¹ for operators A, B as above.	4	
Q4 (A)	Consider a state $ \Psi\rangle$, which is given in terms of three orthonormal vectors $ \phi_1\rangle$, $ \phi_2\rangle$, and $ \phi_3\rangle$ as follows: $ \psi\rangle = \frac{1}{\sqrt{15}} \phi_1\rangle + \frac{1}{\sqrt{3}} \phi_2\rangle + \frac{1}{\sqrt{5}} \phi_3\rangle,$	4	IV
	where $ \phi_n\rangle$ are eigenstates to an operator B such that: $\hat{B} \phi_n\rangle=(3n^2-1) \phi_n\rangle$		
	with $n = 1, 2, 3$. Calculate the norm of the state $ \Psi\rangle$ and find the expectation value of B for the eigen state $ \Psi\rangle$. OR		
	Determine the expectation value of B^2 for the state $ \Psi\rangle$. Operator B is defined as above.	4	





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В	Consider an unpolarised electron beam: 25% spin up state $ 0\rangle$ and 75% spin down state $ 1\rangle$.	6	IV
	Calculate the density matrix for the given system.		
	Determine the expectation value of the operator which is given by		
	$\hat{A} = \begin{bmatrix} 7 & -3i \\ 3i & 5 \end{bmatrix}$		
С	State the following properties of commutators for the operators A, B and C (1) Linearity and (2) Distributive	2	IV
D	Consider a particle whose Hamiltonian matrix is $H = \begin{pmatrix} 2 & i & 0 \\ -i & 1 & 1 \\ 0 & 1 & 0 \end{pmatrix}.$	6	IV
	Calculate the eigen values of H and normalized energy eigenvectors for the corresponding eigen values of H.		