



DEPARTMENT OF PHYSICS AND RESEARCH CENTER VTU-RC
PRE FINAL QUESTION PAPER-2025-2026 I SEM CSE A

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Course Code: 1BPHYS102

First Semester B.E. Degree Pre final Examination, January
2025 Quantum Physics and Applications (CSE Stream)

TIME: 3 hrs.

Max.Marks:100

Note: 1. Answer any FIVE full questions, choosing ONE question from each MODULE

2. VTU Formula Hand Books Permitted

3. M: Marks, L: Bloom's level, C: Course outcomes. Prepared by: Dr. NAGABHUSHANA N M

		Module-1	M	L	C
Q.1	a	Assuming time independent Schrodinger wave equation, discuss the solution for a particle in a potential well of infinite height and hence obtain the normalized wave function and its energy value.	8	L2	CO1
	b	Discuss Heisenberg's uncertainty principle and state the three relationships. Use the energy-time uncertainty to explain the broadening of spectral lines.	8	L2	CO1
	c	Compute de brogli wave length of an electron moving with a potential 500V.	4	L3	CO1
OR					
Q.2	a	Setup time independent Schrodinger wave equation for one dimension	7	L2	CO1
	b	Discuss the principle of complementarity and physical significance of a wave function.	8	L2	CO1
	c	An electron is bound in an one dimensional potential well of width 1 \AA , but of infinite wall height. Compute its energy value in the ground state and first two excited states.	5	L3	CO1
Module-2					
Q.3	a	Explain the Failure of Classical free electron theory of metals and the Assumptions of Quantum free electron theory.	8	L2	CO2
	b	Show that Fermi energy of intrinsic semiconductor in is half times energy gap of the semi conductor	8	L2	CO2
	c	Calculate the probability of an electron occupying an energy level 0.03eV below the Fermi level at 200K .	4	L3	CO2
OR					
Q.4	a	Prove that the Fermi energy in an intrinsic semiconductor at finite temperature differs from its value at $T=0 \text{ K}$ by a value proportional to the temperature.	7	L2	CO2
	b	What is Hall effect and Hall coefficient? Derive the expression for Hall coefficient and Hall voltage.	8	L2	CO2
	c	A semiconductor sample 0.5mm thick carries a current of 5mA in a magnetic field of 0.2 T . If the Hall voltage is 1 mV , determine the Hall coefficient.	5	L3	CO2

Module-3					
Q.5	a	Discuss in depth about BCS theory for superconductors.	8	L2	CO3
	b	What is Josephson effect? Explain DC & AC Josephson effects with a neat sketch.	8	L2	CO3
	c	A superconducting wire of radius 0.25mm carries a persistent current in a magnetic field of 0.05 T. Calculate the critical current.	4	L3	CO3
OR					
Q.6	a	What are phonons? Explain pockel effect and Kerr effect. Discuss the construction and working of pockel and kerr cells with a neat sketches.	7	L2	CO3
	b	What is Messner effect? Explain Type I and Type II superconductors using M-H characteristics curves.	8	L2	CO3
	c	For a superconducting sample with critical temperature 7.2K and critical field at 0K is $6.5 \times 10^4 \text{ Am}^{-1}$, find the critical field at 4 K	5	L3	CO3
Module-4					
Q.7	a	What is acceptance angle and Numerical aperture? Derive an expression for the numerical aperture and acceptance angle of an optical fibre, with the help of a neat labeled diagram.	8	L2	CO4
	b	Explain the working of a SNSPD with a neat diagram.	7	L2	CO4
	c	A fiber has a core refractive index of 1.48 and a cladding index of 1.46. Calculate its numerical aperture (NA) and acceptance angle in air and water. Given RI of water is 1.33.	5	L3	CO4
OR					
Q.8	a	Explain the principle and working of a Single Photon Avalanche Diode.	8	L2	CO4
	b	Obtain an expression for the energy density using Einstein's A and B coefficients.	7	L2	CO4
	c	Calculate the V-number and number of modes supported by an optical fiber of core radius 25 μm , operating at wavelength 1.3 μm with NA = 0.2.	5	L3	CO4
Module-5					
Q.9	a	Define a qubit. Explain the concept of superposition and represent it on the Bloch sphere.	7	L2	CO5
	b	What are pauli matrices? explain the operation of these matrices with $ 0\rangle$ and $ 1\rangle$ states.	7	L2	CO5
	c	A quantum state is given by $ \psi\rangle = (1/\sqrt{3}) 0\rangle + (\sqrt{2}/\sqrt{3}) 1\rangle$. Calculate the probability of obtaining $ 1\rangle$ and the expectation value of σ_z .	6	L3	CO5
OR					
Q.10	a	Explain the Hadamard gate with its matrix representation and show its action on $ 0\rangle$ and $ 1\rangle$ states.	7	L2	CO5
	b	Discuss the operation of the CNOT with circuit and truth table	7	L2	CO5
	c	A two-qubit system is initially in the state $ 00\rangle$. It passes through a Hadamard gate on the first qubit followed by a CNOT gate. Determine the final state vector.	6	L3	CO5
