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EAST POINT COLLEGE OF ENGINEERING & TECHNOLOGY
An Autonomous Institution Affiliated to Visvesvaraya Technological University (VTU) Belagavi

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25PHC12/25PHC22

First/Second Semester B.E. Degree Examination, June/July 2026
QUANTUM PHYSICS AND APPLICATIONS

TIME:3 hrs. Max.Marks:100

Note: 1. Answer **any FIVE** full questions, choosing **ONE** question from **each MODULE.**
2. Formula Hand Books Permitted.
3. M: Marks, L: Bloom's level, C: Course outcomes.
4. Assume missing data suitably.

		Module-1	M	L	C
Q.1	a	Explain de Broglie hypothesis and derive an expression for the expression for the de Broglie wavelength.	7	L2	CO1
	b	Derive time-independent Schrödinger wave equation.	8	L3	CO1
	c	An electron is confined to a 1D infinite potential well of width 0.2nm. Calculate its ground state energy. *(Given: $h = 6.63 \times 10^{-34}$ J.s, $m = 9.11 \times 10^{-31}$ kg, 1 eV = 1.6×10^{-19} J)*	5	L3	CO1
		OR			
Q.2	a	State and explain Heisenberg uncertainty principle with application to spectral line broadening.	7	L2	CO1
	b	Explain physical significance of wave function and normalization condition.	8	L2	CO1
	c	A particle is confined in a region $0 \le x \le L$ with a wave function given by $\psi(x)=A\sin(\pi x/L)$. Find the normalization constant 'A'.	5	L3	CO1
		Module–2			
Q.3	a	Discuss failures of classical free electron theory.	7	L2	CO2
	b	Derive expression for carrier concentration in intrinsic semiconductors.	8	L3	CO2
	c	At what energy level E is the probability of finding an electron in a metal is exactly 50% at any temperature above absolute zero? Prove this using the Fermi-Dirac distribution function.	5	L3	CO2
		OR			
Q.4	a	List the assumption of QFET and explain its merits.	7	L3	CO2
	b	Describe Hall effect phenomena and derive expression for Hall Coefficient.	8	L2	CO2
	c	A semiconductor of thickness 0.4 mm carries a current of 5 mA in a perpendicular magnetic field of 0.8 T. If the measured Hall voltage is 20mV, calculate the Hall coefficient (R_H) of the material.	5	L3	CO2
		Module–3			
Q.5	a	Distinguish between Type-I and Type-II superconductors with examples.	7	L3	CO3
	b	Derive expression for critical current using Ampere circuit law.	8	L3	CO3
	c	A superconducting material has a critical magnetic field of 3.2×10^4 A/m at 0 K. If its critical temperature (T_c) is9.2 K, calculate the critical magnetic field (H_c) at an operating temperature of 4.6K.	5	L3	CO3

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		OR			
Q.6	**a**	Explain the construction and working of RF/AC SQUID, mention their applications.	**7**	**L3**	**CO3**
	b	Explain BCS theory of superconductivity with emphasis on Cooper pair formation and energy gap.	**8**	**L2**	**CO3**
	c	The critical current of a super conducting wire is 6.4 x 10^3A.Find the critical field. Radius of the wire is 5mm	**5**	**L3**	**CO3**
		Module–4			
Q.7	**a**	Derive an expression for energy density in terms of Einstein coefficient.	**7**	**L3**	**CO4**
	b	Derive expression for numerical aperture of optical fiber.	**8**	**L3**	**CO4**
	c	An optical fiber has a core material of refractive index 1.5 and cladding material of 1.41. If the light is launched into it in air, calculate the numerical aperture and the maximum angle of acceptance.	**5**	**L3**	**CO4**
		OR			
Q.8	**a**	Explain construction and working principle of semiconductor LASER.	**7**	**L2**	**CO4**
	b	Explain the working principle of Single Photon Avalanche Diode (SPAD) and Superconducting Nanowire Single Photon Detector (SNSPD) with suitable diagrams and compare their performance.	**8**	**L2**	**CO4**
	c	A multimode step-index fiber has a core radius of 25 μm and a numerical aperture (NA) of 0.22. If the fiber is operated at a wavelength of 1.3 μm, calculate the V-number and the total number of guided modes (M) supported by the fiber.	**5**	**L3**	**CO4**
		Module–5			
Q.9	**a**	Distinguish between classical bits and qubits. Explain their mathematical representation using Dirac notation.	**7**	**L2**	**CO5**
	b	Define and explain the Pauli (X, Y, Z) and Hadamard quantum gates. Provide their matrix representations and demonstrate their action on the computational basis states $\|0\rangle$ and $\|1\rangle$.	**8**	**L3**	**CO5**
	c	A qubit state is represented on a Bloch Sphere with polar angle $\theta = 60^\circ$ and azimuthal angle $\Phi = 90^\circ$. Write the state vector $\|\psi\rangle$ in Dirac notation.	**5**	**L3**	**CO5**
		OR			
Q.10	**a**	Discuss CNOT gate and two-qubit operations.	**7**	**L2**	**CO5**
	b	Explain the concept of quantum superposition and measurement. Illustrate how measurement affects the state of a qubit.	**8**	**L2**	**CO5**
	c	Show that Hadamard gate is unitory.	**5**	**L3**	**CO5**

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