U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

April 2025 Semester End Make-Up Examinations

Programme: B.E. **Semester: I**

Branch: CSE/AI&ML/BT **Duration: 3 hrs.**

Course Code: 22PH1BSPCS **Max Marks: 100**

Course: Applied Physics for Computer Science Stream

Instructions: 1. Answer any FIVE full questions, choosing one full question from each Module.
2. Missing data, if any, may be suitably assumed.

Physical constants:

Mass of electron, $m_e = 9.1\times10^{-31}$ kg

Electronic charge, $e = 1.602\times10^{-19}$ C

Boltzmann constant, $k_B = 1.38\times10^{-23}$ J/K

Permittivity of free space, $\varepsilon_o = 8.85\times10^{-12}$ F/m

Speed of light, $c = 3\times10^{8}$ m/s

Planck constant, $h = 6.626\times10^{-34}$ Js

Mass of neutron, $m_n = 1.67\times10^{-27}$ kg

Mass of proton, $m_p = 1.67\times10^{-27}$ kg

		MODULE - I	CO	PO	Marks
1	a)	Define numerical aperture in optical fiber. Show that the light gathering capacity of an optical fiber surrounded by air is equal to $\sqrt{n_1^2 - n_2^2}$. Where the terms have their usual meaning.	CO1	PO1	8
	b)	Discuss the general conditions for laser action. Explain the construction and working of semiconductor laser with suitable diagrams.	CO1	PO1	8
	c)	An optical fiber has a core material with refractive index 1.55 and its cladding material has a refractive index of 1.5. The light is launched into it in air. Calculate its N.A, and fractional refractive index change.	CO1	PO2	4
		OR			
2	a)	If A & B are the Einstein coefficients, then show that $B_{21} = B_{12}$ where the notations have their usual meaning.	CO1	PO1	8
	b)	Define attenuation. Discuss the causes of signal attenuation in an optical fiber.	CO1	PO1	8
	c)	The transition to the ground state from upper state and lower energy states in a ruby laser result in emission of photons of wavelengths 6928 A° and 6943 A° respectively. Estimate the energy values of the two energy levels in eV and also their ratio of populations. Given T = 270 °C. Assume ground state energy = 0.	CO1	PO2	4

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

			MODULE - II			
	3	a)	Mention the properties of the wave function. Prove the non-existence of electron within the nucleus of an atom using Heisenberg's uncertainty principle.	***CO1***	***PO1***	**8**
		b)	Starting from the normalized wave function for a particle confined in a 1-D potential well, discuss the wave function, probability density and energy Eigen values for the ground and the first excited states.	***CO1***	***PO1***	**8**
		c)	Compare the kinetic energy of a photon with that of an electron when both are associated with a wavelength 0.2 nm.	***CO1***	***PO2***	**4**
			OR			
	4	a)	Define group and phase velocity. Deduce the relations of group velocity with particle velocity.	***CO1***	***PO1***	**8**
		b)	Describe the physical significance of Heisenberg's uncertainty principle. Setup the expression for 1-D time independent Schrodinger wave equation.	***CO1***	***PO1***	**8**
		c)	A particle of mass 0.55 MeV/c^2 has a kinetic energy of 70 eV. Calculate the de-Broglie wavelength and group velocity of the wave.	***CO1***	***PO2***	**4**
			MODULE - III			
	5	a)	Mention the assumptions of quantum free electron theory. Discuss the any two demerits of classical free electron theory.	***CO1***	***PO1***	**8**
		b)	Deduce an expression for electronic polarizability exhibited by a pure elemental dielectric material.	***CO1***	***PO1***	**8**
		c)	Find the electron density of a metal with Fermi energy 3 eV.	***CO1***	***PO2***	**4**
			OR			
	6	a)	Define Fermi factor and Fermi energy. Discuss Fermi factor for the cases $E<E_F$, $E>E_F$ at T= 0 K and $E=E_F$ at T> 0 K with neat illustration.	***CO1***	***PO1***	**8**
		b)	Derive an expression for internal field in one dimensional array of atoms in dielectric solids.	***CO1***	***PO1***	**8**
		c)	The dielectric constant of Helium at 0^o C is 1.000074. The density of atoms is 2.7×10^{25} atoms per m^3. Calculate the dipole moment induced in each atom when the gas is in an electric field of 3×10^4 V/m.	***CO1***	***PO2***	**4**

			MODULE - IV			
	7	a)	What is Meissner effect. Explain different types superconductors with example.	*CO1*	*PO1*	**8**
		b)	Derive an expression for the number of electrons per unit volume in the conduction band of a semiconductor, assuming the density of energy states in it.	*CO1*	*PO1*	**8**
		c)	For intrinsic gallium arsenide, the room temperature electrical resistivity is 10^{-6} /Ω-m, the electron and hole mobilities are respectively 0.85 m^2/Vs and 0.04 m^2/Vs. Compute the intrinsic carrier concentration at room temperature.	*CO1*	*PO2*	**4**
			OR			
	8	a)	Discuss the phenomenon of Hall effect with neat sketch and hence deduce an expression for Hall voltage in terms of Hall coefficient in semiconductors.	*CO1*	*PO1*	**8**
		b)	Describe (a) BCS theory in superconductors (b) magnetically levitating vehicle.	*CO1*	*PO1*	**8**
		c)	Calculate the critical current for a wire of lead having a diameter of 1 mm at 5.2 K. Critical temperature for lead is 8.18 K and H_0 = 6.5 X 10^4 Am^{-1}	*CO1*	*PO2*	**4**
			MODULE - V			
	9	a)	What are the Pauli Matrices? Show their operations on |0> and |1> states.	*CO1*	*PO1*	**8**
		b)	Write the truth table, diagram and matrices for Toffoli gate and Hadamard gate.	*CO1*	*PO1*	**8**
		c)	A liner operator X operates such that X |1> = |0>. Find the matrix representation of X.	*CO1*	*PO2*	**4**
			OR			
	10	a)	Explain Moore's law and its end. Differentiate between classical and quantum computing.	*CO1*	*PO1*	**8**
		b)	Write the truth table, diagram and matrices for quantum T gate and controlled Z gate.	*CO1*	*PO1*	**8**
		c)	Show that $U = \begin{bmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ \frac{-i}{\sqrt{2}} & \frac{i}{\sqrt{2}} \end{bmatrix}$ is unitary.	*CO1*	*PO2*	**4**

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