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PES University, Bengaluru

(Established Under Karnataka Act 16 of 2013)

UE21PH141B

JULY 2022: END SEMESTER ASSESSMENT (ESA) B.Tech. II SEMESTER

UE21PH141B: ENGINEERING PHYSICS

Time: 3 Hours **Answer all questions** **Max Marks:100**

Useful constants:

$m_e = 9.1 \times 10^{-31}$ kg	$h = 6.63 \times 10^{-34}$ Js	$k_B = 1.38 \times 10^{-23}$ JK^{-1}
$c = 3 \times 10^8$ ms^{-1}	$= 8.854 \times 10^{-12}$ Fm^{-1}	$m_p = 1.67 \times 10^{-27}$ kg

1.	**a)**	Show that the electric and magnetic field vectors of the electromagnetic waves are normal to each other as well as to the direction of propagation of the radiation.	**5**
	b)	State de-Broglie's hypothesis. Evaluate the condition under which the group velocity of a wave packet is half the phase velocity.	**5**
	c)	State the characteristics of a well behaved wave function. Normalize the wave function given by .	**5** **(3+2)**
	F **d)**	State two illustrations of Heisenberg's uncertainty principle. If the average time period that elapses between the excitation of an atom and the time it radiates energy is , then calculate the uncertainty in the energy of emitted photon and the limit of accuracy with which the frequency of the emitted radiation can be determined.	**5** **(2+3)**
2.	**a)**	Starting from Schrödinger's time dependent wave equation set up time independent Schrödinger's equation for a particle.	**5**
	b)	A particle travelling with energy 'E' along -axis has in its path a rectangular potential barrier of height $V_0 > E$ and a width 'L'. Discuss the possible wave functions of the particle in the different regions. Evaluate the zero-point energy Eigen value of a quantum linear harmonic oscillator with period of 2 pico-second.	**6** **(4+2)**
	c)	Derive the expression of energy values using the admissible solutions for a particle in an infinite potential well of the form, and	**6**
	d)	Illustrate with an example what is meant by degeneracy of energy states in quantum systems.	**3**
	a)		**6**

3.		On the basis of classical free electron model, obtain an expression for electrical conductivity in metals. Calculate the drift velocity and thermal velocity of conduction electrons in copper at a temperature of 300 K, when a copper wire of length 2 m and resistance 0.04 Ω carries a current of 16 A. Given the mobility of free electrons in copper is 4.2×10^{-3} m^2/Vs.	**(3+3)**
	b)	Using the expression of density of states show that at 0K, the average energy of the valence electrons is $(3/5)^{th}$ of the Fermi energy.	**4**
	c)	Describe the nature of potential experienced by valence electrons according to Kronig-Penney model. Elaborate with suitable schematic the dependence of effective mass of electrons on the curvature of the E-k plot.	**6 (3+3)**
	d)	Briefly highlight the conceptual features of the BCS theory of superconductivity.	**4**
4.	**a)**	Explain how population inversion is achieved in a He-Ne laser.	**4**
	b)	What are the essential requisites of a laser system? Calculate the threshold gain factor of a laser system, which has loss factor of 0.05 m^{-1}, with tube length of 50 cm having one mirror 99% reflecting and the output coupler 90% reflecting.	**6 (3+3)**
	c)	Explain briefly the following: (i) Stimulated emission (ii) Temporal coherence (iii) Possible laser transitions in CO_2 laser	**6 (2+2 +2)**
	d)	Explain the factors 'carrier confinement' and 'photon confinement' with reference to double heterojunction devices.	**4**
5.	**a)**	What is Larmor precession? Obtain an expression for induced magnetic moment of a precessing charge in terms of Larmor frequency.	**5**
	b)	Briefly describe the functionality of a GMR device and mention its important applications.	**5**
	c)	What are the components of the electric fields that prevail in a dielectric? An elemental dielectric has 7×10^{28} atoms per unit volume and a dielectric constant of 9. Calculate the atomic polarizability of the material.	**5 (2+3)**
	d)	Compare the phenomenon of ferroelectricity and piezoelectricity.	**5**

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