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PES University, Bangalore
(Established under Karnataka Act No. 16 of 2013)

UE21PH141A

MARCH 2022: END SEMESTER ASSESSMENT (ESA) B.Tech. I SEMESTER

UE21PH141A: ENGINEERING PHYSICS

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

Constants:	$m_e = 9.1x10^{-31}$ kg	$e = 1.6x10^{-19}\ C$	$k_B = 1.38 \times 10^{-23}$ JK $^{-1}$
$c = 3x10^8$ ms^{-1}	$h = 6.626x10^{-34}$ Js	$\varepsilon_0 = 8.854 \times 10^{-12}\ Fm^{-1}$	$\mu_0 = 4\pi \times 10^{-7}\ Hm^{-1}$

1.	a)	Using Maxwell's equations, how did Maxwell propose that light is an electromagnetic wave?	4
	b)	Give a brief account on i) Planck's Quantum hypothesis for black body radiation ii) Experimental observations of Compton shift iii) Operators and expectation values in quantum mechanics	6
	c)	Distinguish between phase velocity and group velocity in wave motion. Find the group velocity of an electron whose de-Broglie wavelength is 0.12 nm.	4
	d)	Describe the physical meaning of the position-momentum uncertainty relation. The uncertainty in the velocity of a particle is equal to its velocity. If $(\Delta x)(\Delta p) \cong h$, show that the uncertainty in its location is equal to its de-Broglie wavelength.	6
2.	a)	Write the Schrodinger's wave equation for steady state and discuss its solutions for a particle incident on a step potential from a region of zero potential with energy E less than the step height V_0.	5
	b)	Explain barrier tunneling. Give one application where tunneling is observed. Calculate the probability of transmission for an electron of energy 2 eV incident on a rectangular potential energy barrier of height 4 eV and width 10^{-9}m.	5
	c)	Sketch the Eigen functions and probability density curves of the first two allowed quantum states for a particle in a finite potential well.	4
	d)	How do the potential and energy Eigenvalues of a particle exhibiting simple harmonic oscillations differ from that of a particle trapped in an infinite potential well? The first excited state energy of an electron in an infinite potential well is 240 eV. What will be its ground state energy when the width of the potential well is doubled?	6
3.	a)	What are the main differences between the classical and quantum free electron theories developed for metals?	4
	b)	Discuss the variation of Fermi factor for different conditions of temperature and consequent effect on probability of occupation of energy levels. Plot it for 0 K and at any temp T K.	6

3.	c)	A conduction wire has a resistivity of $1.54 \times 10^{-8}\Omega$m at room temperature. The Fermi energy for such a conductor is 5.5 eV. There are 5.8×10^{28} conduction electrons per m^3. Calculate i) The relaxation time for electrons ii) The velocity of an electron with Fermi energy iii) The mean free path of the electrons	5
	d)	Explain i) How are solids classified on the basis of band theory of solids? ii) How does a superconductor differ from a normal conductor?	5
4.	a)	Establish the relation between Einstein's A and B coefficients. Using Einstein's theory, show that for a wavelength $\lambda = 5000\ A^0$ in the optical region and at T=300 K, amplification of light is impossible.	8
	b)	Outline briefly any two special characteristics of Laser light.	2
	c)	What are the specific requirements for the construction of He-Ne laser and describe its working with the help of an energy level diagram. How is it different from CO_2 laser?	8
	d)	Explain the recording of the hologram.	2
5.	a)	Explain the atomic origin of magnetic effects in materials. With the necessary expressions, show that the orbital magnetic moment is half of the spin magnetic moment for electrons.	5
	b)	Describe the hysteresis property of a magnetic material and state its importance in selecting a magnetic material for a particular application.	5
	c)	Briefly explain i) Ferroelectric Curie temperature ii) Orientational polarization iii) Inverse Piezoelectric effect iv) Pyroelectricity	4
	d)	Write and give the significance of Clausius-Mosotti equation. If NaCl is subjected to an electrical field of 1000 Vm^{-1} and the resulting polarization is $4.3 \times 10^{-8} Cm^{-2}$, calculate the relative permittivity of NaCl.	6

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