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PES University, Bengaluru

(Established under Karnataka Act No. 16 of 2013)

UE20PH101

July/August 2021: END SEMESTER ASSESSMENT (ESA) B TECH II SEMESTER

UE20PH101 – ENGINEERING PHYSICS

Time: 3 Hr	Answer All Questions	Max Marks: 100

$| \mathbf{m_e = 9.1x10^{-31}\ kg} \quad | \quad \mathbf{h = 6.63x10^{-34}Js} \quad | \quad \mathbf{k_B = 1.38\ x\ 10^{-23}\ JK^{-1}} \quad |$

$| \mathbf{c = 3x10^8\ ms^{-1}} \quad | \quad \mathbf{N_A = 6.02x10^{23}\ per\ mol} \quad | \quad \boldsymbol{m_p = 1.67 \times 10^{-27}\ kg} \quad |$

1	a)	By using Maxwell's equations for free space obtain the differential equations describing the electric and magnetic fields.	5
	b)	An electron and a photon have a wavelength of 5 angstrom. Calculate their momenta and total energies.	4
	c)	Explain the uncertainty principle. If the speed of an electron is measured to be $3 \times 10^3\ ms^{-1}$ with an accuracy of 0.004 % estimate the uncertainty in the position of the particle.	5
	d)	Define the following terms used in quantum mechanics. i. Wavefunction ii. Normalization iii. Observable iv. Eigen values v. Eigen functions vi. Hamiltonian	6
2	a)	A beam of particles of mass $\boldsymbol{m}$ and total energy $\boldsymbol{E}$ is incident on a **potential step** of height $\boldsymbol{V_0}$. If $\boldsymbol{E > V_0}$ then by applying continuity conditions obtain the expression for the reflection coefficient.	5
	b)	Draw the sketch of a barrier potential. A proton of energy 3 MeV is incident on a potential **barrier** of height 10 MeV and thickness $2 \times 10^{-14}\ m$. Estimate the transmission coefficient.	5
	c)	Obtain the Eigen values and normalized Eigen functions for a particle in an **Infinite** Potential Well defined as $\boldsymbol{V = 0}\ for - \frac{a}{2} \leq x \leq \frac{a}{2}$ and $V = \infty$ everywhere else.	6

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	d)	Write a note on a quantum harmonic oscillator. Find the first two energy Eigen values of a particle undergoing SHM with a fundamental frequency $10^{13}\ Hz$.	4
3	a)	Discuss any three failures of Classical free electron theory.	5
	b)	Show the dependence of the density of states on energy using a plot. Derive an expression for the average energy of free electrons.	5
	c)	Explain the following terms with expressions wherever necessary i. Fermi factor ii. Fermi temperature iii. Fermi energy iv. Fermions	6
	d)	Explain how specific heat is calculated according to the quantum free electron theory along with a discussion on Wiedemann-Franz law.	4
4	a)	What is population inversion? Define the basic requirements of a laser system.	4
	b)	Discuss the following terms i. Life time and meta-stable state ii. Spatial coherence iii. Gain and loss in a laser cavity iv. Frequency comb	6
	c)	Give a comprehensive idea of the working of a He-Ne laser by including the construction aspects and the energy level diagram.	5
	d)	What are direct and indirect band semiconductors? Discuss the working of a heterojunction diode laser.	5
5	a)	Give a brief account of Diamagnetism and Paramagnetism.	5
	b)	Explain the phenomenon of Giant Magneto Resistance.	5
	c)	What are polar dielectrics? Explain the idea of orientation polarization and how the susceptibility varies with temperature in polar dielectrics.	5
	d)	Give examples of ferroelectric and piezoelectric materials along with their applications.	5