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SECOND SEMESTER **B. Tech. [All Groups]**

MID SEMESTER EXAMINATION ***March 2019***

AP102: PHYSICS-II

Time: 1.5 Hours ***Max. Marks: 30***

Note: Attempt *ALL* questions.
Assume suitable missing data, if any.

1 [a] Consider a particle trapped in an infinite potential box of width a,

$$V(x) = \begin{cases} 0, & 0 < x < a \\ \infty, & x \leq 0, x \geq a \end{cases}$$

Write the Schrodinger equation for this particle and hence get the expressions for the energy eigen values and energy eigen functions for the particle. Draw its fourth energy eigen function. 3

[b] Find the expectation value $\langle x \rangle$ and $\langle p_x \rangle$ of the position and momentum, respectively, of a particle trapped in one dimensional box of width a. Discuss the significance of the results. 3

2 [a] Show that the de Broglie wavelength of a particle of rest mass m_0 and kinetic energy KE is given by

$$\lambda = \frac{hc}{\sqrt{KE(KE + 2m_0c^2)}}$$ 3

[b] An electron is put in a cubical box of each side 1Å. Find the values of its momentum and energy for the ground state and first excited state. 3

3 [a] X-rays of wavelength 10 pm are scattered from a target. (I) Find the wavelength of the x-rays scattered through 45°. (II) Find the maximum wavelength present in the scattered x-rays. (III) Find the maximum kinetic energy of the recoil electrons. 3

[b] For copper the conductivity is 5.8×10^7 mhos/m and one may assume $\mu=\mu_0$. Find the skin depth or penetration depth at the frequencies of 100 Hz and 100 MHz. Explain the results physically. 3

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4 [a] Write the Maxwell's equations in their differential form and use them to deduce the integral form of the equations. Briefly explain the physical meaning of the Maxwell's equations. 3

[b] What is displacement current density $\overrightarrow{J_D}$ and explain how did Maxwell use the continuity equation to introduce the term $\overrightarrow{J_D}$ in order to modify the Ampere's law. Also explain, how did the introduction of the term $\overrightarrow{J_D}$ revolutionize the physics. 3

5 [a] Derive the wave equations for propagation of electric field $\vec{E}$ and magnetic field $\vec{H}$ in free space. Show that the $\vec{E}$ and $\vec{H}$ in plane electromagnetic waves are mutually perpendicular in a plane normal to the direction of wave propagation. 3

[b] Define Poynting vector $\vec{S}$. The electric field vector for an electromagnetic field travelling in vacuum is given by

$$\vec{E} = E_0 \cos(kz - wt)\,\hat{x}$$

Calculate the Poynting vector for the wave and show that its magnitude is equal to the energy density of the wave times the velocity of light.

END