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SECOND SEMESTER
MID SEMESTER EXAMINATION
AP102: PHYSICS-II

Roll No.....
B. Tech. [All Groups]
March 2019

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

$$\lambda = \frac{hc}{\sqrt{KE(KE + 2m_0c^2)}}$$
- [b] An electron is put in a cubical box of each side 1\AA . Find the values of its momentum and energy for the ground state and first excited state.
- 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.
- [b] For copper the conductivity is $5.8 \times 10^7\text{ mhos/m}$ 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.

P.T.O.

- 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 \vec{J}_D and explain how did Maxwell use the continuity equation to introduce the term \vec{J}_D in order to modify the Ampere's law. Also explain, how did the introduction of the term \vec{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