RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. FOURTH SEMESTER EXAMINATION, AUGUST 2021

SECOND YEAR (BATCH 2019-22)

Date : 07/08/2021 **PHYSICS (Honours)**

Time : 11.00 am – 1.00 pm **Paper : VIII [CC 8]** Full Marks : 50

Answer **any five** questions [5×10]

1. a) Write down Macwell's equations in free space and explain properly each of the equation. Show how you get the equation of local conservation of charge from there equations.

   b) If the current density $\bar{J} = \bar{J}(\bar{r})$ but the charge density $\rho = \rho(\vec{r}, t)$ deduce an expression for ρ using the continuity equation. [5+2+3]

2. a) For a wave $E_x = 0, E_y = E_0 \text{Sin}(kz + \omega t), E_z = 0, B_x = 0, B_y = 0, B_z = -E_0 \text{Sin}(kz + \omega t)$. What is the relation between ω and k so that Maxwell's equation are satisfied. Find out the type of wave the fields generate.

   b) If $\vec{E} = E_0 (\hat{i} + \hat{j}) \text{Sin}(kz + \omega t)$, $E_0 = 2$ statvolts, Find out $\bar{B}$. (exclude any static B). What is the total charge density ρ associated with such a field?

   c) A plane electromagnetic wave with $\bar{E}$ polarised along the propagation vector $\vec{K}$ is travelling with $\hat{k} = \left(\frac{\hat{i} + \hat{j}}{\sqrt{2}} \right)$. Write down the expression for $\bar{E}$ and $\bar{B}$. [3+4+3]

3. a) Establish the law of conservation of energy in an electromagnetic wave.

   b) Current flows down a wire of length *l* and radius *r*. under a potential difference *V*. Calculate the energy delivered per unit time to the wire and show that it is equivalent to Joule law. [5+5]

4. a) Prove that in a conductor the electric and the magnetic fields are no longer in phase and energy is not shared equally between them.

   b) A charged parallel plate capacitor (neglect edge effect) is immersed in sea-water. If the charge $q = q_0 \text{Sin}(2\pi\upsilon t), \upsilon = 4 \times 10^8 \text{Hz}$ and $\in = 81 \in_0$ ($\in_0$ = dielectric constant of free space), compare the conduction and the displacement currents. [7+3]

5. a) Deduce equations of wave propagation inside a conducting medium. What happens to the wave as it propagates inside the medium?

   b) The terms 'good' and 'poor' conductor depend on frequency. Explain. [8+2]

6. a) Assuming boundary conditions find out the relation between the angle of incidence, angle of reflection and angle of transmission as an electromagnetic wave propagates from one non-conducting medium to the other.

   b) Assuming normal incidence deduce the relation between the amplitudes of the electric field of the reflected wave, the incident wave and the transmitted wave. [5+5]

7. a) Using Fresnel's formula prove that two possible directions of displacement vector $\vec{D}$ for a given vector in anisotropic media are orthogonal.

   b) An unpolarised light passes through two successive polaroids (P_1 and P_2) the polaroid P_1 makes an angle θ with the axis of the polaroid P_2. Find out the intensity of final out coming light, and if θ is varied from 0 to 2π, plot the intensity variation graph. [5+(2+3)]

8. a) How do you produce circularly polarised light from a unpolarised light?

   b) A right circularly polarised beam $\left(\lambda_0 = 5893\,\overset{0}{\text{A}}\right)$ is incident normally on a calcite crystal (with optic axis cut parallel to the surface) of thickness 0.01148 mm. What will be the state of polarisation of the emergent beam.

   $\left(n_0 - n_e = 0.17195\right.$ where n_0 and n_e are refracted index of 0 and E ray).

   c) What is nicol prism? [3+(5+2)]

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