

B.Sc. Semester VI (Honours) Examination, 2021 (CBCS)

Subject: Physics

Paper: CC-XIII

Time: 2 Hours

Full Marks: 40

The figures in the margin indicate full marks. Candidates are required to give their answers in their own words as far as practicable.

Answer any eight of the following questions (all questions carry equal marks) 5×8=40

1. a) Discuss the non-uniqueness of electromagnetic potentials (\vec{A} and ϕ).
- b) Write down equations corresponding to the following statements
 - i) Magnetic monopole does not exist.
 - ii) Electric monopole exists.
 - iii) Total electric charge is conserved.
2. a) Show that the electromagnetic potentials in uniform electric and magnetic field may be expressed as $\phi = -\vec{E} \cdot \vec{r}$ and $\vec{A} = \frac{1}{2}(\vec{B} \times \vec{r})$ (with usual meanings of the symbols)
- b) If x and y components of electric field vector of an electromagnetic wave be $E_x = a_1 \sin \alpha x$ and $E_y = a_2 \sin(\alpha x + \delta)$, with usual meanings of the symbols.

Show that for $\delta = (m + \frac{1}{2})\pi$ where $m=1,2,3, \dots$, you get elliptic polarization.

3. a) Show that, for an electromagnetic wave propagating in a conducting medium, the electric and magnetic fields are not in phase and that the energy is not shared equally between the electric and magnetic field.
- b) An electric field in free space is of the form $\vec{E}(\vec{r}, t) = E_0 \hat{x} \sin^3(z - ct)$. Can it be an electromagnetic wave?
4. Deduce an expression for the refractive index of a dilute ionized gaseous medium. Hence show that (i) electromagnetic wave of frequency less than plasma frequency cannot propagate through the medium and (ii) plasma frequency $f_p = 8.98n_e^{\frac{1}{2}}$, c/s, where n_e is electron number density. [$e = 1.6 \times 10^{-19} C$, $m = 9 \times 10^{-31} kg$, $\epsilon_0 = 8.85 \times 10^{-12} SI$]

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Xiaolong Qi



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