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 $\phi = -\vec{E}.\vec{r}$ 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 $E_x = a_1 \sin \omega t$ and $E_y = a_2 \sin(\omega t + \delta)$,with usual meanings of the symbols.

Show that for $\delta = (m + \frac{1}{2})\pi$ where m=1,2,3 …… , 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 $f_p = 8.98 n_e^{\frac{1}{2}}$ c/s , where n_e is electron number density.[$e = 1.6 \times 10^{-19} C$, $m = 9 \times 10^{-31} kg$, $\varepsilon_0 = 8.85 \times 10^{-18} SI$]

5. A plane polarised electromagnetic wave with its electric vector parallel to the plane of incidence is incident obliquely on the interface between two dielectrics. Obtain expressions for the amplitude reflection and transmission coefficients. Hence prove Brewster's law.

6. a) What is a wave guide? Considering TE or TM waves propagating along a rectangular wave guide with perfectly conducting walls, find out the cut off wave length (λ_c)

b) Write down the dielectric tensor for (i) anisotropic medium (ii) isotropic medium.

7. a) Show that a plane polarized light can be considered as the superposition of two circularly polarised waves rotating in opposite directions.

b) Can you recognise with naked eye whether the given light is polarised or not ? Explain.

8. Explain working of Babinet's compensator. Why this device is superior to quarter wave plate? Explain how it can be used to analyse elliptically polarised light.

9. Give the construction and action of Laurent's half-shade polarimeter. Explain how it can be used to find the concentration of sugar solution.

10. a) What are meant by acceptance angle and numerical aperture of a fibre? Find their expressions for a step-index fibre.

b) Show that numerical aperture (NA) is related to fractional index change Δ, by the equation $NA = n_1\sqrt{2\Delta}$, n_1 is the index of the core.