This question paper contains 4 printed pages]

Roll No. | | | | | | | | | | | |

S. No. of Question Paper : **1600**

Unique Paper Code : **222601** **C**

Name of the Course : **B.Sc. (Hons.) Physics**

Name of the Paper : **Electromagnetic Theory (PHHT-619)**

Semester : **VI**

Duration : **3 Hours** Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *Five* questions in all.

All questions carry equal marks.

Question No. **1** is compulsory.

1. Answer any *five* of the following : 5×3=15

(*a*) Find the units of the following :

(*i*) $\oint \mathrm{D} \cdot d\mathrm{S}$

(*ii*) $\oint \mathrm{E} \cdot dl$

(*b*) For a plane electromagnetic wave propagating in vacuum with electric field amplitude E_0. Find the expression for the momentum density.

(*c*) Determine the skin depth of graphite at 10 GHz given that $\sigma = 10^5$ mho/m.

P.T.O.

(*d*) Calculate the minimum thickness of a calcite plate the would convert a plane polarized light of wavelength 5890 A into circularly polarized light, given that $\mu_0 = 1.658$ and $\mu_e = 1.486$.

(*e*) An electromagnetic wave polarized parallel to plane of incidence is incident from air on to distilled water with $\mu_r = 1$ and $\epsilon_r = 81$. Find the Brewster angle.

(*f*) Draw the wavefronts for light propagating from isotropic to a positive uniaxially anisotropic medium when the optic axis is parallel to both the interface and the plane of incidence.

(*g*) Plot the variation of refractive index with radial distance for :

(*i*) step-index and

(*ii*) graded-index fiber.

2. (*a*) What are electomagnetic vector and scalar potentials ? Show that although these potentials are not unique in themselves they define the fields $\vec{E}$ and $\vec{B}$ uniquely. 2,5

(*b*) Calculate the characteristic impedance of free space for propagation of plane electromagnetic wave through it. Can any material medium possess a characteristic impedance greater than this value ? 4

(*c*) If the earth receives 1400 Joules m^{-2} sec^{-1} solar energy, what are the amplitudes of the electric and magnetic fields of radiation. 4

3. (*a*) Discuss how Maxwell's modified Ampere's law to make it consistent with the equation of continuity. Explain the significance of displacement current. 6,4

(*b*) The magnitude of magnetic field vector $\vec{H}$ of a plane electromagnetic wave in vacuum is 1.5 A/m. Find the magnitude of the electric field vector $\vec{E}$ of the wave. 5

4. (*a*) What is a Plasma ? State in brief the conditions for its existence. Derive an expression for the refractive index of a collision-free plasma. 2,2,5

(*b*) Discuss the significance of plasma frequency in the transmission of radio waves through the ionosphere. 2

(*c*) The average density of electrons (N_e) in an ionosphere is 9×10^{10} electrons/m^3. Calculate the plasma frequency (f_p) and the phase velocity of a plane electromagnetic wave of frequency (f) 200 MHz propagating through the ionosphere. 4

5. (*a*) Prove that in an anisotropic medium the displacement vectors $\vec{D}_1$ and $\vec{D}_2$ associated with the two modes of propagation are normal to each other. 8

(*b*) For a given direction of wave vector obtain expressions for the two phase velocities in a uniaxial crystal in terms of its principal velocities. 7

6. (*a*) Show that for a plane electromagnetic wave suffering total internal reflection at the interface of two dielectric media. although the transmitted wave exists in the second dielectric medium the time average Poynting vector associated with the wave is zero. 7

(*b*) Starting from the appropriate Fresnel's relations for the case of the electric field vector $\vec{E}$ of an electromagnetic wave polarized parallel to the plane of incidence, show that for a particular angle of incidence there is not reflected wave. Hence obtain an expression for the same. 4.4

7. (*a*) Describe the concept of Laurent's half shade device used in a polarimeter. What are its advantages ? 5.2

(*b*) Show that the superposition of a left-handed and right-handed circularly polarized light produces a plane polarized light. 4

(*c*) Discuss how Nicol prism can be used for the production and analysis of plane polarized light. 4

Value of constants :

$$\mu_0 = 4\pi \times 10^{-7} \text{ H/m},$$

$$\varepsilon_0 = 9.0 \times 10^{-12} \text{ F/m}$$

$$q_e = 1.6 \cdot 10^{-19} \text{ C}$$

$$m_e = 9.11 \times 10^{-31} \text{ kg}$$

$$c = 3 \times 10^8 \text{ m/sec.}$$