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Roll No.

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S. No. of Question Paper : 6228

Unique Paper Code : 2221502

F-5

Name of the Paper : Electromagnetic Theory

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

Semester : V

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. Attempt any five of the following :

5×3=15

- (a) Calculate the displacement current through a parallel plate air filled capacitor having plates of area 10 cm^2 separated by a distance of 2 mm and connected to 360 V, 1 MHz source.
- (b) Explain the significance of loss tangent when electromagnetic wave travels in different media.
- (c) Calculate the skin depth for a conductor at 1 GHz given that $\sigma = 3.8 \times 10^7 \text{ mho/m}$, $\mu = 2.57 \times 10^{-7} \text{ H/m}$.

P.T.O.

- (d) What is meant by Attenuation Constant ? Write the relation between neper and decibel.
- (e) Discuss the phenomena of total internal reflection on the basis of electromagnetic theory.
- (f) How would you optically distinguish between circularly polarized light and unpolarized light ?
- (g) On the basis of scattering of light explain the colour of sky.
2. (a) Define scalar and vector potentials. Show that the Maxwell's equations can be expressed as two coupled second order differential equations in terms of scalar and vector potentials. What is Lorentz condition ? How do the above equations get simplified using Lorentz condition ?
- (b) Show that for electromagnetic fields the average energy density is given by

$$U = \frac{1}{2}(\epsilon_0 E^2 + \mu_0 H^2). \quad 12,3$$
3. (a) State and prove Poynting theorem. Explain the physical significance of each term in the theorem.
- (b) Show that the expression for time average Poynting vector for time varying fields is given by $\langle S \rangle = \frac{1}{2} \text{Re}(E \times H^*)$. Where H^* is the complex conjugate of vector H . 8,7
4. (a) What is plasma ? Obtain an expression for plasma oscillation frequency.
- (b) Show that the critical frequency for propagation of electromagnetic waves in plasma is given by $9\sqrt{N}$. Where N is the electron density in plasma.
- (c) Obtain an expression for refractive index of the ionosphere. 7,4,4

5. (a) Derive Fresnel's relations for reflection and transmission of plane electromagnetic waves at an interface between two dielectric media when an electric vector of the incident wave is parallel to the plane of incidence.
- (b) Find the expression for the Brewster's angle at which the reflected wave is completely extinguished. Why this angle is called polarizing angle ? 9,6
6. (a) Derive an expression for power radiated by an oscillating electric dipole.
- (b) What is retarded potential ? Explain the significance of retarded potential. 10,5
7. (a) Derive the transformation laws for the electric and magnetic fields in the case of parallel plate capacitor.
- (b) Do static electromagnetic fields possess linear and angular momentum ? Give reasons. 10,5