10/5/19

[This question paper contains 4 printed pages]

**Your Roll No.** : .....

**Sl. No. of Q. Paper** : **2267** **IC**

Unique Paper Code : 32221601

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

Name of the Paper : Electromagnetic Theory

Semester : VI

***Time : 3 Hours*** ***Maximum Marks : 75***

**Instructions for Candidates :**

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

(b) Attempt any **five** questions.

(c) Question **No. 1** is compulsory.

(d) **All** questions carry equal marks.

(e) Scientific calculator is allowed.

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

(a) In a lossy dielectric of relative permittivity 12 the displacement current is 25 times greater than the conduction current at 100MHz. Calculate the conductivity of dielectric.

(b) Mention any two differences between half and quarter wave plates.

P.T.O.

(c) Calculate the minimum thickness of calcite plate which would convert plane polarized light into circularly polarized light. Given $n_0$=1.568, $n_e$=1.468 and $\lambda$=5890 Å$^0$.

(d) In an optical fibre the core refractive index is 1.5 and cladding refractive index is 1.47. Determine critical angle at core clad interface and numerical aperture.

(e) Using Faraday's law, find the intrinsic impedance of free space.

(f) In what respect does an electrically anisotropic medium differ from an isotropic medium. Mention at least **two** points.

(g) Show that in plasma electron current lags the electric field by $\pi/2$.

(h) Can perfectly static fields possess momentum and angular momentum ?

**2.** (a) Show how Maxwell modified Ampere's law to make it consistent with the equation of continuity. 3

(b) Show that the Maxwell's equations can be expressed as two coupled second order differential equations in term of scalar and vector potentials. How does these two equations get modified after Lorentz gauge ? 8,4

**3.** (a) Derive wave equation for E of an em wave in a conducting medium. 4

(b) Show that the amplitude of electric field of em wave attenuates as it propagates in a conducting medium. 8

(c) Find the expression for skin depth. 3





**4.** (a) Show that in an electrically anisotropic dielectric medium the permittivity tensor is symmetric. 6

(b) Show that in anisotropic dielectric medium the electric field, magnetic field and the Poynting's vector on one hand and the electric displacement, magnetic field and the wave normal on the other hand form orthogonal triplets. 9

**5.** (a) Derive Fresnel's relations for reflection and refraction of plane em wave at an interface between dielectric media when the electric field vector of the incident wave is normal to the plane of incidence. Also find the expressions for R and T. 8

(b) If a parallel polarized em wave is incident from air onto distilled water with $\mu_r = 1$ and $\epsilon_r$ =81, find the Brewster angle $\theta_B$. 3

**6.** (a) How would you optically distinguish between circularly polarized light and plane polarized light ? 4

(b) Explain the construction and working of a Nicol prism. 8

(c) What is graded index optical fibre ? Give its one advantage over step index fibre in optical communication. 3

**7.** (a) Derive wave equation for E of em wave in a symmetric planar dielectric wave guide whose refractive index [$n^2 = n^2(x)$] profile is :

$n = n_1$, $-d/2 < x < d/2$

$= n_2$, $x < -d/2, x > d/2$.

Using the boundary conditions, obtain the eigenvalue equation for symmetric TE modes. 8,4

(b) Show that there exists only one symmetric TE mode for $0 < V < \pi$, where V denotes the dimensionless wave guide parameter. 3

**8.** (a) A long straight conducting wire of radius b and conductivity $\sigma$ is kept along z-axis and it carries a direct current I in +z-direction. Calculate the Poynting's vector on the surface of this wire. 5

(b) Calculate the reflection coefficient at normal incidence for a plane em wave incident on silver from vacuum ($f = 10^{15}$ Hz, $\sigma = 6 \times 10^7$ mho/m). 5

(c) Find the maximum usable frequency for em waves to be transmitted through a distance of $1.5 \times 10^6$m by reflection from the ionosphere at a height of 300 km. (number of electrons per unit volume in ionosphere is $6 \times 10^{11} m^{-3}$) 5