End Semester Examination, 2022

Semester - VI

Physics

PAPER - C13T

Full Marks : 40

Time : 2 Hours

Group - A

1. ***Answer any five questions :***   ***5x2=10***

a) Show that displacement current and conduction current are equal in magnitude in a particular circuit.

b) In a medium of dielectric constant 5, the maximum displacement current is equal to the maximum conduction current at a frequency of 1 MHz. Find the conductivity of the medium.

c) What are the significance of gauge transformation ?

d) The intensity of sunlight reaching the earth's surface is about 2 calorie. cm^{-2}, min^{-1}. Calculate the strength of electric field of in coming sunlight.

e) Show that equation of continuity $\vec{\nabla} \times \vec{J} + \frac{\partial p}{\partial t} = 0$ is contained in Maxwell's equation.

f) State Brewster's law. What is Brewster's angle ?

(Turn Over)

g) Show that Vp Vg = c², where Vp and Vg are the phase and group velocity, c is velocity of light in free space.

h) What is the difference between optical rotation and specific rotation ?

Group - B

Answer any four questions :   *4x5=20*

2.a) Show that electric, magnetic and propagation vectors form a set of orthogonal vectors in free space.

b) Also show that, electric and magnetic field vectors are in phase and constant in ratio.   3+2

3. Starting from the Maxwell's equation find the diffarential equation satisfied by the magnetic vector potential $\vec{A}$. Derive the condition for which the equation simplifies to a wave equation.   3+2

4.a) What is skin depth ?

b) Show that the skin depth in a poor conductor is in dependent of frequency and is given by

$$\delta = \frac{2}{\sigma}\sqrt{\frac{\varepsilon}{\mu}}$$

where symbols has their usual meaning.   2+3

5.a) What is a waveguide ?

b) Show that TEM waves can not occur in a hollow waveguide.   2+3

6. The electric field of an electromagnetic wave propagating through vaccum is given by

$$\vec{E}(\vec{r},t) = E_0\hat{Z}Cos\left(100\sqrt{3}\Pi x - 100\Pi y - wt\right)$$

a) What is the wave vector $\vec{K}$? Hence find the value of w.

b) At the time $t = 0$, there is a point charge q with velocity $\vec{V} = V_0\hat{x}$ at the origin. What is the instantaneous Lorentz force acting on the particle ?2+3

7. If x and y component of electric vector of an electromagnetic wave be

$Ex = a_1\sin wt$ and $Ey = a_2 \sin(wt + \delta)$

where symbol has their usual meaning.

Show that —

(i) for $\delta = 2m\Pi$ the e.m. wave is linearly polarized, where m = 1, 2, 3, ...

(ii) for $\delta = \left(m + \frac{1}{2}\right)\Pi$, we get elliptic polarization, where m = 1, 2, 3, ...

(iv) When does the ellipse become a circle ? 2+2+1

Group - C

Answer any one questions :   *1x10=10*

8.a) State and establish Poynting's theorem. Show that the theorem can be expressed as

$$\frac{\partial u}{\partial t} + \vec{\nabla}.\vec{S} = 0$$

where $\vec{S} = \frac{1}{\mu_0}\left(\vec{E} \times \vec{B}\right)$ and u is the total electromagnetic energy density