U.G. 6th Semester Examination - 2020

PHYSICS

Course Code : BPHSCCHC601

Course Title : Electromagnetic Theory

Full Marks : 30 Time : 2 Hours

The figures in the right-hand margin indicate marks.

Candidates are required to give their answers in their own words as far as practicable.

1. Answer any **ten** questions: 1×10=10

a) $\vec{E} = E_m \sin(\omega t - \beta z)\hat{j}$ in free space, find out the expression for $\vec{H}$.

b) Show that the Maxwell's equations include the equation of continuity.

c) What do you mean by displacement current?

d) Which quantities of EM field are Lorentz invariant?

e) Write one difference between normal and anomalous dispersion.

f) What is plasma frequency?

g) Estimate the ratio of the skin depths in copper at frequencies of 1 kHz and 10 kHz.

h) Calculate the magnitude of Poynting vector at teh surface of the Sun. Given that power radiated by Sun=3.8×10^{26} watts and radius of Sun=7×10^{8}m.

i) If at a point on boundary between two dielectric The electric field make angles θ_1 and θ_2 with the normal in media of permittivity ε_1 and ε_2 respectively, then show that $\frac{\tan\theta_1}{\tan\theta_2} = \frac{\varepsilon_1}{\varepsilon_2}$.

j) What will be the state of polarization of a horizontal polarized light passes through a quarter wave plate at $\theta = 45^o$.

k) How ordinary and extraordinary ray differ from each other?

l) Mention the uses of Babinet compensator.

m) How can you use Nicol prism as analyzer?

n) What is an optic axis?.

o) What are the advantages of guided medium over coaxial cables a twisted wire pairs?

2. Answer any **five** questions: 2×5=10

a) Derive the law of conservation of charge from Maxwell's field equations.

b) Write Maxwell's equations in Lorentz invariant form.

c) In a non-magnetic medium

$$\vec{E} = 4\sin\left(22\times10^{7}t - 0.8x\right)\hat{k}\ \text{V/m}$$

determine relative permittivity and intrinsic impedance of the medium. $\left[\sqrt{\frac{\mu_0}{\varepsilon_0}} = 120\pi\right]$

d) Prove that in the case of gases the maximum and minimum values of refractive index occur at the position where the absorption coefficient reaches half its maximum value.

e) Show that the Brewster's angle / polarization angles for external and internal reflection at the interface between the same media are complements of each other.

f) Calculate the thickness of a quarter-wave plate for sodium light of wavelength 589.3nm. Given n_0=1.5442 and n_e=1.5533.

g) Write two uses of Biot's laws for rotatory polarization.

h) Explain briefly the principle behind the operation of optical fiber as waveguide.

3. Answer any **two** questions: 5×2=10

a) Derive the Maxwell's equations in terms of Scalar potential, ϕ and vector potential A. What is the advantage of writing these equations in terms of ϕ and A? 3+2

b) An electromagnetic wave is incident at the surface of two linear homogeneous dielectric. What are the boundary conditions at the surface? Find out the ratio of the electric field intensities for normal incidence. 2+3

c) The scalar and vector potentials are given by $\phi(\vec{r},t) = 0$ and $A(\vec{r},t) = -\frac{qt}{4\pi\varepsilon_0 r^2}\hat{r}$. Find the electric and magnetic fields. Use the gauge transformation function $\Psi = -\frac{qt}{4\pi\varepsilon_0 r^2}$ to transform the potentials (the symbols have their usual meanings). 2+3

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