U.G. 6th Semester Examination - 2021

PHYSICS

[HONOURS]

Course Code : PHY-H-CC-T-13

(Electro-magnetic Theory)

Full Marks : 40 Time : $2\frac{1}{2}$ 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 **five** questions: 2×5=10

   a) What is evanescent wave?

   b) What is dichroism?

   c) A ray of light is incident on a glass plate (refractive index = 1.5) at the polarizing angle. Find the corresponding angle of refraction.

   d) Write down Maxwell's equations for a conducting medium.

   e) For silver the conductivity $\sigma = 3\times10^7$ mho/m. Find its skin depth at a frequency of 10 GHz.

   f) State Poynting's theorem.

   g) Distinguish between 'step-index' fibre and 'graded-index' fibre.

   h) What is rotatory disperson?

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

   a) State Biot's law for rotatory polarization. Define specific rotation. The specific rotation of the quartz for λ =508.6 nm is 29.73deg/mm. Calculate the difference between refractive indices for left and right circularly polarized light for quartz. 2+1+2

   b) For transverse electric waves propagating along a rectangular wave guide with perfectly conducting walls find the expression for cut-off wave length, guide wave length and velocity of energy propagation. 5

   c) What is Babinet's compensator? Explain how it can be used to analyze elliptically polarized light. 1+4

   d) Show that under suitable conditions $\vec{A}$ and φ satisfy the inhomogeneous equations $\left(\nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\right)\vec{A} = -\mu_0\vec{J}$; $\left(\nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\right)\varphi = -\frac{\rho}{\varepsilon_0}$. 5

3. Answer any **two** questions: 10×2=20

a) What is quarter wave plate? How it can be used for the production of circularly polarized light? If n_0 is the refractive index for O-rays, n_e is the principal refractive index for E-rays (in the direction perpendicular to the optic axis) then show that the refractive index for E-rays in a direction making an angle θ with the optic axis is given by

$$\frac{1}{n_\theta^2} = \frac{cos^2\theta}{n_0^2} + \frac{sin^2\theta}{n_e^2}$$ 2+(2+2)+4

b) Write down Maxwell's equations for the wave propagation in dilute plasma. Deduce an expression for plasma frequency. Hence find the refractive index and skin depth for plasma. 2+4+(2+2)

c) Deduce Fresnel's laws of reflection of e.m. wave at the boundary between two dielectric media. Show that the Brewster's law of polarization is a direct consequence of Fresnel's laws of reflection. Show that the polarizing angle for internal and external reflections at a given interface are complementary to each other. 6+2+2

d) i) State and explain Malus's law. Suppose you have a pair of two crossed polaroids. A thin polaroid is placed between them and made to rotate at a rate ω about their common central axis. An unpolarized light of intensity I_0 is incident on the first polaroid. Show that the intensity of the transmitted light is given by $I = \frac{I_0}{16}(1 - cos\,4\omega t)$.

ii) Starting from Maxwell's equation derive the equations for the e.m. waves in free space. Hence show that the electric field vector, magnetic field vector and propagation vector are all mutually perpendicular to each other. (2+3)+(2+3)

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