U.G. 6th Semester Examination - 2022

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 optic axis?

   b) An unpolarised light of intensity I_0 is incident on two perfect linear polarisers oriented at 45^o with each other. what would be the intensity of transmitted light?

   c) Write down Maxwell's equations for a dilute plasma.

   d) A light is incident normally at water-glass interface. Find the reflectance and transmittance. Take the refractive indices of water and glass as 1.33 and 1.52 respectively.

   e) What is the radiation pressure of a light beam of intensity $1.5kWm^{-2}$?

   f) A step-index fibre has a core of refractive index 1.52 and a cladding of refractive index 1.48. Determine its numerical aperture and the acceptance angle?

   g) What is birefringence

   h) What is evanescent wave?

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

   a) Write the Lorentz gauge conditions and hence derive the inhomogeneous wave equation for scalar and vector potentials. What is advantage of Coulomb gauge? 4+1

   b) What are isotropic, uniaxial and biaxial medium? Define refractive indices in these media. Compare the velocity of waves in these media. 2+2+1

   c) How can you distinguish between an elliptically polarised light and a mixture plane polarized and unpolarised light? 5

d) Consider normal incidence of electromagnetic wave at the boundary between two dielectric media. Derive expressions for reflectance and transmittance. 5

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

a) For transverse electric waves propagating along a rectangular wave guide with perfectly conducting walls find the expression for cut-of wave length, guide wave length and velocity of energy propagation. Show that TEM mode is not possible in a rectangular waveguide. The width of a rectangular waveguide is 4.8 cm. If the free space wavelength of an electromagnetic wave is 3 cm, find its speed through the waveguide when it travels down the waveguide in $(TE)_{10}$ mode. 5+2+3

b) A plane electromagnetic wave travelling in a dielectric is incident normally on the surface of a conductor. Show that the field amplitudes are spatially attenuated inside the conductor. Hence find the expression for skin depth. Also show that $\vec{E}$ and $\vec{H}$ are not in phase inside the conductor. Describe the state of polarisation of the wave represented by $\vec{E}(z,t) = \hat{\imath}E_0 \cos\left(\omega t - kz + \frac{\pi}{2}\right) + \hat{\jmath}E_0 \cos(\omega t - kz)$ 4+2+2+2

c) Give Fresnel's theory of rotation of the plane of polarisation by an optically active substance. Derive an expression for the angle by which the plane of polarisation of a plane polarised light is rotated in passing through a thickness '*d*' of the material. How can you experimentally justify the theory? A plane polarised light of wavelength 600 nm changes to a circularly polarized light on passing through a quafiy crystal cut parallel to optic axis. Calculate the minimum thickness to produce such effect. Given $n_e - n_0 = 0.005$. 2+4+2+2

d) A plane electromagnetic wave is incident obliquely on a boundary between media of different electric and magnetic properties. Derive Fresnel's formulae. Show that the Poynting vector is the electromagnetic energy density multiplied by the phase velocity. 7+3

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