RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. FOURTH SEMESTER EXAMINATION, JUNE 2022

SECOND YEAR [BATCH 2020-23]

Date : 21/06/2022 **PHYSICS (HONOURS)**

Time : 11 am – 1 pm **Paper : VIII [CC8]** Full Marks : 50

Answer **any five** questions: [5×10]

1. a) Establish the Poynting theorem in the following form

$$-\frac{dU_{em}}{dt}=\oint_A \vec{S}.d\vec{A}+P$$

where the symbols have usual meaning. [5]

b) Show that the angle between reflected and transmitted beam is 90^o when beam is incident at Brewster angle. [5]

2. a) Establish Maxwell's equations for the propagation of electromagnetic waves in a conducting medium and show that inside the conductor the magnetic field vector $\vec{H}$ lags behind the electric field $\vec{E}$. [2+4]

b) Protons having the same velocity *v* from a beam of a cricular-section with current *I*. Find the direction and magnitude of Poynting vector(S) outside the beam at a distance *r* from its axis. [4]

3. a) What are gauge transformations? What are Coulomb's and Lorentz gauges. [2+3]

b) A uniform plane wave in air with $\vec{E}=8\cos\left(4x+3z-\omega t\right)\hat{y}V/m$ incident on a dielectric slab $\left(z\geq 0\right)$ with $\mu_r=1.0,\ \in_r=2.25$. Find (i) The polarization of the wave, (ii) The angle of incident (iii) The reflected electric field $\vec{E}$ (iv) The transmitted magnetic field $\vec{H}$. [1+1+1+2]

4. a) Obtain the boundary condition satisfied by the electromagnetic field vector $\vec{H}$. [3]

b) Find the expression for amplitude coefficient of reflection and transmission for $\vec{E}$ field polarized parallel to the plane of incidence. [5]

c) Calculate the degree of polarisation for ordinary light reflected from glass (refractive index 1.5) at an angle of polarisaiton 45^o. [2]

5. a) Establish the Evanescent wave and show that the net energy flow through the surface into second medium is zero. [3+1]

b) In a medium characterized by $\sigma=0,\ \rho=0,\ \mu_r=1,\ \in_r=4$ and electric field $\vec{E}=15\sin\left(10^8 t-\beta z\right)\hat{x}\ V/m$. Calculate β and $\vec{H}$. [6]

6. a) Derive the law of conservation of charge from Maxwell's equations. [3]

b) Show that the refractive index(*n*) of ionised gas (dilute plasma) is given by $n=\sqrt{1-\frac{81n_o}{f^2}}$, where n_o is electron density and *f* is the frequency. [4]

c) Show that the electromagnetic potentials in uniform electric and magnetic field may be expressed as

$$\phi = \vec{E}.\vec{r} \text{ and } \vec{A} = \frac{1}{2}\left(\vec{B} \times \vec{r}\right)$$

where $\vec{r}$ is the position vector of the point under consideration. [3]

7. a) Establish the Fresnel's equation for the propagation of monochromatic plane wave in anisotropic media. [6]

b) Prove that two possible direction of displacement vector $\left(\vec{D}\right)$ for a given wave vectors are orthogonal. [3]

c) Define optical activity? [1]

8. a) What are quarter and half wave plate? [3]

b) A left circularly polarised beam $\left(\lambda_0 = 5893 \overset{o}{A}\right)$ is incident on a quartz crystal (with optic axis cut parallel to the surface) of thickness 0.1625 mm. Determine the state of polarisation of the emergent beam. Assume n_o and n_e to be 1.54425 and 1.55336 respectively. [5]

c) A curtain length of 5% solution (concentration) causes an optical rotation of 20%. How much length of 20% solution of the same substance will cause a rotation of 35^o. [2]

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