(c) For a light beam passing from air to glass (n = 1.5), find the angle of incidence at which reflection vanishes. (3)

5. (a) Discuss the propagation of EM waves in an anisotropic medium and define dielectric tensor. (10)

(b) Distinguish between plane, circular, and elliptically polarized light with sketches. (5)

(c) A quartz plate of thickness 0.6 mm has refractive indices 1.553 and 1.544 for e- and o- rays respectively. For which wavelength will it act as a quarter-wave plate? (3)

6. (a) Derive the eigenvalue equation for TE modes in a planar dielectric waveguide. (12)

(b) Explain phase and group velocities in guided waves. (6)

Constants :

$\varepsilon_0 = 8.854 \times 10^{-12}$F/m and $\mu_0 = 4\pi \times 10^{-7}$H/m

Intrinsic impedance of free space: $\eta_0 \sim 377\ \Omega$

Speed of light $c = 1/\sqrt{\mu_0 \varepsilon_0} \approx 3 \times 10^8$ m/s.

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5716 **K**

Unique Paper Code : 2222013501

Name of the Paper : Electromagnetic Theory

Name of the Course : **B.Sc. (H) Physics_NEP-UGCF-2022**

Semester : V

Duration : 3 Hours Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **FIVE** questions in all.
3. Question No. **1** is compulsory.
4. Scientific (non-programmable) calculators are allowed.

1. Attempt any **6** parts of the following : (6×3=18)

   (i) Write Maxwell's equations in differential form and mention the physical significance of each term.

   (ii) Define Coulomb and Lorentz gauges. What is the advantage of using Lorentz gauge in wave propagation problems?

   (iii) What are the conditions for a crystal plate to act as a quarter-wave and a half-wave plate.

   (iv) What is the difference between optical rotation and polarization rotation?

   (v) What is an extraordinary ray? In which crystal does it occur?

   (vi) A plane EM wave of frequency 1 GHz propagates in copper ($\sigma = 5.8\times10^7$ S/m, $\mu = \mu_0$). Find the skin depth.

   (vii) The specific rotation of sugar solution is 66° dm^{-1} $(g\ cm^{-3})^{-1}$. A 10 cm tube produces a rotation of 13°. Find the concentration of the solution.

2. (a) Derive Poynting's theorem and interpret each term. (10)

   (b) Explain the concept of energy flow in electromagnetic fields using an example. (5)

   (c) Sunlight incident on Earth delivers about 1.3 kW/m^2. Find the amplitude of the electric and magnetic fields associated with sunlight. (3)

3. (a) Starting from Maxwell's equations, derive the electromagnetic wave equation in free space. (8)

   (b) Prove that electromagnetic waves in vacuum are transverse in nature. (5)

   (c) An EM wave has $E = 100 \cos (2\pi \times 10^8 t - \beta z)$ V/m in a medium with $\varepsilon = 4\varepsilon_0$, $\mu = \mu_0$. Find the wave velocity and intrinsic impedance. (5)

4. (a) State and derive Fresnel's formulae for perpendicular polarization. (10)

   (b) Explain Brewster's angle and show how it can be used for polarization. (5)

P.T.O.