1 (Sem–3/FYUGP) PHY42MN/(A)

2025

PHYSICS

(Minor)

Paper : PHY4300204 MN

(SET–A)

(Electromagnetic Theory)

Full Marks : 45

Time : 2 hours

The figures in the margin indicate full marks for the questions.

1. Answer ***all*** questions : 1×5=5

   (a) Write the basic difference between the propagation of electromagnetic waves through conducting and non-conducting mediums.

(b) Write down the boundary condition of $\dot{H}$.

(c) Write the expression for group-velocity dispersion.

(d) What is the function of cladding in optical fiber?

(e) Define phase retardation plate.

2. Answer ***any five*** : 2×5=10

(a) Show that the ratio of conduction current density (J_C) and displacement current density (J_D) is equal to $\sigma/\omega\varepsilon_0$.

(b) Draw the variation of amplitude reflection coefficients r parallel and r perpendicular with respect to the incident angle.

(c) Define optic axis. What type of crystal possesses only one optic axis?

(d) Write down the mathematical expression and unit of energy flux density.

(e) What is elliptical and circular polarized light?

(f) What is displacement current?

(g) What are electromagnetic potentials?

(h) Classify the optically active substance with example.

(i) What do you mean by an anisotropic medium?

(j) Write the expression for guided wave length.

3. Answer ***any four*** : 5×4=20

(a) Write the Poynting theorem in differential from. What does the Poynting vector signify? Consider the propagation of an *em* wave with electric field vector given by $E = E_0 \sin(kz - \omega t)\hat{x}$. Calculate the Poynting vector.

(b) What is rotatory polarization ? Draw a neat diagram of the Laurent half-shade polarimeter, labeling each part of it. 2+3=5

(c) Show that for an em wave in a conducting medium, the ratio between H and E vectors is a complex value signify.

(d) Show that the critical frequency for propagation of electromagnetic waves in plasma is given by $f_c = 9\sqrt{n_o}$, where n_o is the number of electrons per cubic meter. Comment on the propagation of em wave incident on plasma with frequency less than the plasma frequency. 4+1=5

(e) Discuss how circular and elliptical polarization of electromagnetic waves can be obtained.

(f) Describe the action of Nicol prism as analyses with the help of proper diagram.

(g) Write short note on : ***(any one)***

(1) Double refraction

(2) Laurent's half-shade polarimeter

(h) Show that $E = -\Delta\phi - \frac{\partial A}{\partial t}$. Discuss also the gauge transformation. Write the expression for Lorentz gauge.

4. Answer ***any one*** : 10×1=10

(a) Explain how optical fibres are classified on the basic of the refractive index profile. From the consideration of parabolic relation of refractive index, derive the ray path in graded index fibres. Write the *two* types of fibre optic sensors. 2+6+2=10

(b) Discuss with the neat diagram the construction of Babinet compensator can be used to analyze elliptically polarized light. 4+6=10

(c) What are wave guides? List *one* difference between transmission lines and wave guides. Draw a net diagram of the propagation of waves between two parallel conducting plates. Define the term TE, TM and TEM associated with the propagation of electromagnetic waves through a wave guide.

(d) Describe the construction and working principle of Lorentz half shade polarimeter. What is specific rotation of a solution? 3+4+3=10
