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3 (Sem-6/CBCS) PHY HC 1

2022

PHYSICS

(Honours)

Paper : PHY-HC-6016

(Electromagnetic Theory)

Full Marks : 60

Time : Three hours

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

1. Answer **any seven** questions : $1 \times 7 = 7$

(a) What is a plane wave ?

(b) Why cannot a plane wave propagate in a conducting medium without attenuation ?

(c) What do you mean by scalar potential ?

Contd.

- (d) In propagation of EM wave the relation between wave vector and electric field intensity is given as $\vec{k} \cdot \vec{E} = 0$. What does this equation signify ?
- (e) How are refractive index, magnetic permeability and electric permittivity related ?
- (f) What is polarizing angle ?
- (g) Define reflection co-efficient.
- (h) What do you mean by anisotropic medium ?
- (i) What is a wave guide ?
- (j) Draw the path of light through graded index fibre.

2. Answer **any four** of the following questions : 2×4=8

(a) We know that intensity of a light source is given by $1.33 \times 10^{-3} E_0^2$ where E_0 is electric field intensity. Also intensity of the source is power per unit area. What is the electric field intensity of a laser beam of 10^5 watt with beam cross-sectional area 10^{-6} square *cm* ?

(b) What is the physical significance of displacement current ?

(c) When a plane polarised EM wave is incident on the interface of *two* dielectrics, which components of \vec{E} and \vec{D} and also \vec{B} and \vec{H} are continuous ?

(d) What is evanescent wave ?

(e) What is the function of a half-wave plate ?

(f) Give *one* example each of uniaxial and biaxial crystals.

(g) What do you mean by specific rotation of a liquid ?

(h) Give the differences between single mode and multiple mode fibres.

3. Answer **any three** of the following questions : $5 \times 3 = 15$

(a) State the *four* Maxwell's equations and write their physical significances.

(b) Construct the electromagnetic wave equation in free space. What is its velocity ?

Qm

(c) Show that for a plane wave in conducting medium propagation vector is complex.

(d) How will you use Babinet compensator to analyse polarization of light ?

(e) What are transverse electric and transverse magnetic modes of EM wave in a waveguide? *Q*

(f) Derive an expression of numerical aperture for an optical fibre.

(g) Define optic axis in terms of wave surface.

(h) Derive an expression for plasma frequency.

4. Answer **any three** of the following questions : $10 \times 3 = 30$

(a) Defining Poynting vector. Establish the fact that the rate of decrease of total energy is equal to joule loss plus the net flow out of the surface enclosing the volume.

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(b) What are gauge transformations ? Find the conditions of Lorentz gauge and Coulomb gauge. $2+(6+2)=10$

(c) Derive Fresnel's relation for EM wave with \vec{E} perpendicular to the plane of incidence with proper diagram.

(d) Estimate the proportion of incident power which is transmitted when a plane wave with frequency 10 GHz is incident onto a slab of thickness 8 mm and dielectric constant 2.5 .

(e) Using Fresnel's relation, discuss the phenomenon of total internal reflection for electric vector polarised perpendicular to plane of incidence. What is skin depth ? Derive its expression for a conducting medium.

$6+1+3=10$

- (f) How can you produce and analyse circularly and elliptically polarized lights ? Explain with relevant ray diagram. $(2+2+2+2)+2=10$
- (g) Explain how you will measure specific rotation of a liquid by half shade polarimeter.
- (h) How will you determine the angle at which energy must be coupled into a dielectric waveguide ?