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(6th Semester)

PHYSICS

ELEVENTH PAPER

(Electromagnetic Theory)

(Pre-revised)

Full Marks : 55

Time : 2½ hours

(PART : A—OBJECTIVE)

(*Marks* : 20)

The figures in the margin indicate full marks for the questions

SECTION—A

(*Marks* : 5)

Tick (✓) the correct answer in the brackets provided : 1×5=5

1. In inductor, energy is stored in the form of

(a) electrical energy ( )

(b) magnetic energy ( )

(c) heat energy ( )

(d) No energy is stored in the inductor ( )

2. Energy density of electric field in vacuum is given by (where E_0 is amplitude of electric field)

(a) $u \quad {}_0E_0^2$ ( ) *(b)* $u \quad \frac{1}{2} \; {}_0E_0^2$ ( )

(c) $u \quad \frac{1}{4} \; {}_0E_0^2$ ( ) *(d)* $u \quad {}_0E_0^2 \quad \frac{B_0^2}{0}$ ( )

3. When an electromagnetic wave incidents normally on dielectric surface, the relation between reflection coefficient (R) and transmission coefficient (T) is

(a) $R \quad T \quad 1$ ( ) *(b)* $R \quad T \quad 0$ ( )

(c) $R \quad T \quad 1$ ( ) *(d)* $RT \quad 1$ ( )

4. Lorentz gauge condition is given by

(a) $\vec{} \quad \vec{A} \quad 0$ ( ) *(b)* $\vec{} \quad \vec{A} \quad {}_0 \; {}_0 \frac{}{t}$ ( )

(c) $\vec{} \quad \vec{A} \quad \vec{J}$ ( ) *(d)* $^2 \quad 0$ ( )

5. If P be the average power radiated from an oscillating dipole and frequency of the oscillation is doubled keeping all other variables constant, the new average power radiated from the same dipole is

(a) $2P$ ( ) *(b)* $4P$ ( )

(c) $8P$ ( ) *(d)* $16P$ ( )

SECTION—B

(*Marks* : 15)

Answer the following questions : 3×5=15

1. Write a short note on displacement current.

2. What do you mean by Poynting vector? Write down the relation for the same.

3. What do you mean by Brewster's angle? Hence obtain the relation for Brewster's law.

4. Show that the magnetic scalar potential satisfies Laplace's equation.

5. Write the differences between Normal dispersion and Anomalous dispersion.

(PART : B—DESCRIPTIVE)

(*Marks* : 35)

The figures in the margin indicate full marks for the questions

1. Write down the four Maxwell's equations. Derive any two relations. 1+3+3=7

OR

(a) Show that the normal component of electric field in the boundary of two different media is discontinuous by $\frac{}{0}$, where is surface charge density. 4

(b) Show that displacement current density is given by $\vec{J}$ $_0 \frac{\vec{E}}{t}$. 3

2. *(a)* Obtain the wave equations satisfied by electric and magnetic fields in vacuum and hence show that the speed of electromagnetic wave in vacuum is given by c $\frac{1}{\sqrt{\ _0\ _0}}$. 5

(b) The amplitude of electric field (E_0) in an electromagnetic wave is 20 V/m. Calculate the amplitude of magnetic field (B_0). 2

OR

(a) Establish orthogonality and transverse nature of electromagnetic wave. 5

(b) What do you mean by momentum of electromagnetic wave? Write down the expression for it when the surface is perfect reflector. 2

3. Show that when an electromagnetic wave is incident on conducting medium, the amplitude decreases exponentially. 7

OR

Consider an electromagnetic wave incident obliquely on a dielectric surface. Prove the following (kinematic properties) : 7

(a) Frequency of the wave remains the same

(b) Angle of incidence is equal to angle of reflection

(c) Snell's law

4. *(a)* What do you mean by Gauge transformation? Show that electric and magnetic fields are gauge invariants using the transformations $\vec{A}$ $\vec{A}$ $\rightarrow$ and $\frac{}{t}$ simultaneously. 5

(b) Starting with Maxwell's equation, show that magnetic field can be written in the form $\vec{B}$ $\rightarrow$ $\vec{A}$, where $\vec{A}$ is magnetic vector potential. 2

OR

(a) Show that the total force experienced by a charged particle moving in the region, where both magnetic and electric fields are present is

$$\vec{F} \quad q \quad \rightarrow(\quad \vec{v} \quad \vec{A}) \quad \frac{d\vec{A}}{dt}$$

4

(b) Show that the momentum of a charged particle in an electromagnetic field is given by $\vec{p}$ $m\vec{v}$ $q\vec{A}$. 3

5. *(a)* What do you mean by retarded potential? Discuss it quantitatively. 1+3=4

(b) What do you mean by TE wave? What is cut-off wavelength? 3

OR

Write a note on Lorentz theory of dispersion and hence obtain Cauchy's dispersion law. 7

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