Total No. of Printed Pages—7

5 SEM TDC PHY M 2

2021

(March)

PHYSICS

(Major)

Course : 502

(Electrodynamics)

Full Marks : 60

Pass Marks : 24 /18

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct answer from the following : 1×6=6

(a) If $\vec{E}$ and $\vec{B}$ represent the electric and magnetic field vectors of electromagnetic waves, then the direction of propagation of the electromagnetic wave is that of

(i) $\vec{E}$

(ii) $\vec{B}$

(iii) $\vec{E} \times \vec{B}$

(iv) $\vec{B} \times \vec{E}$

(b) Depth of penetration for silver is

(i) 2·5 m

(ii) 0·01 mm

(iii) 0·0667 mm

(iv) 0·064 mm

(c) The ratio of the electric to the magnetic energy density is

(i) $\frac{\frac{1}{2}\varepsilon E_0^2}{\frac{1}{2}\mu H_0^2} = 1$

(ii) $\frac{\frac{1}{2}\varepsilon E_0^2}{\frac{1}{2}\mu H_0^2} = -1$

(iii) $\frac{\frac{1}{2}\varepsilon E_0^2}{\frac{1}{2}\mu H_0^2} \leq \frac{1}{50}$

(iv) $\frac{\frac{1}{2}\varepsilon E_0^2}{\frac{1}{2}\mu H_0^2} \geq \frac{1}{50}$

(d) A man in a spaceship holds a stick measuring 1 m horizontally. The spaceship is moving along the horizontal with a speed v. The stick is turned inside the spaceship through 90°. The ratio of the length of the stick

(Continued)

as measured by the earth observer, before and after rotation, is

(i) 1

(ii) > 1

(iii) < 1

(iv) zero

(e) If vectors E and H are in phase, the expression for intrinsic impedance of space is

(i) $\sqrt{\frac{\mu}{\varepsilon}}$ (ii) $\sqrt{\frac{\mu_0}{\varepsilon_0}}$

(iii) $\sqrt{\frac{1}{\mu\varepsilon}}$ (iv) $\sqrt{\frac{1}{\mu_0\varepsilon_0}}$

(f) Fresnel's equation in case of s-polarization, the transmission coefficient (T_s) is

(i) $T_s = \frac{2\cos\theta_i}{\cos\theta_i + n_{12}\cos\theta_i}$

(ii) $T_s = \frac{2\cos\theta_i \sin\theta_i}{\cos\theta_i - n_{12}\cos\theta_i}$

(iii) $T_s = \frac{\cos\theta_i - n_{12}\cos\theta_i}{\cos\theta_i + n_{12}\cos\theta_i}$

(iv) $T_s = \frac{\cos\theta_i + n_{12}\cos\theta_i}{\cos\theta_i - n_{12}\cos\theta_i}$

2. Answer any *five* of the following : 3×5=15

(a) Deduce Maxwell's equation from Faraday's law of induction.

(b) What is Brewster's angle? Show that

$$\theta_B = \cot^{-1}\left(\frac{n_1}{n_2}\right)$$

(c) What are the main postulates of Einstein special theory of relativity?

(d) Explain what you understand by magnetic vector potential.

(e) Show that in a good conductor, the phase difference between E vector and H vector is $\pi/4$.

(f) Describe the relativity of simultaneity on the basis of Lorentz transformation equation.

(g) Deduce the value of reflection and transmission coefficients at glass-air interface for normal angle of incidence.

3. *(a)* State Ampere's circuital law and discuss how it was modified to include the displacement current. 4

(b) Find the momentum density and radiation pressure of electromagnetic waves. 2+2=4

4. *(a)* Write down the Maxwell's equations involving the scalar and vector potentials. Explain the gauge transformation used. 5

Or

Obtain Poynting theorem for the conservation of energy in an electromagnetic field and discuss the physical meaning of each term in resulting equation. 5

(b) Calculate the value of Poynting vector at the surface of the sun if the power radiated by sun is $3 \cdot 8 \times 10^{26}$ watt while its radius is 7×10^{8} m. 2

5. *(a)* Show that if the first media is denser, there is a difference of phase between

the reflected parallel and perpendicular components given by

$$\tan \partial/2 = \frac{\cos\theta_i \sqrt{\sin^2\theta_i - \left(\frac{n_2}{n_1}\right)^2}}{\sin^2\theta_i}$$

3

(b) How is the polarization of an electromagnetic wave affected when it crosses the plane interface between two dielectrics? 5

6. A plane electromagnetic wave is incident on a plane boundary between two non-conducting media. Specify the boundary conditions and hence derive Fresnel's formulae for the reflected and transmitted intensities. 5

Or

Obtain the boundary conditions satisfied by electromagnetic field vectors $\vec{B}$ and $\vec{H}$ on a plane surface between two media. 5

7. Explain in brief the nullity of ether-hypothesis. 5

Or

Describe Michelson-Morley experiment and its results. 5

8. *(a)* Obtain the relativistic kinetic energy (T) relation

$$T = m_0 c^2 \left[\frac{1}{\sqrt{1 - v^2 / c^2}} - 1 \right]$$ 4

(b) Deduce the velocity at which the mass of a particle becomes 10 times its rest mass. 2

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