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**5 SEM TDC PHY M 2**

# 2014

( November )

## PHYSICS

( Major )

Course : 502

**( Electrodynamics )**

*Full Marks* : 60

*Pass Marks* : 24

*Time* : 3 hours

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

**1.** Choose the correct answer : 1×6=6

*(a)* The relation between electric field $\vec{E}$ and magnetic field $\vec{H}$ in an electromagnetic wave is

*(i)* $\vec{E} = \vec{H}$

*(ii)* $\vec{E} = \frac{\mu_0}{\varepsilon_0} \vec{H}$

*(iii)* $\vec{E} = \sqrt{\frac{\mu_0}{\varepsilon_0}} \vec{H}$

*(iv)* $\vec{E} = \sqrt{\frac{\varepsilon_0}{\mu_0}} \vec{H}$

(b) Displacement current is

(i) same as conduction current due to flow of electrons

(ii) same as conduction current due to flow of positive ions

(iii) same as conduction current due to flow of both positive and negative charge carriers

(iv) not the conduction current but is caused by time varying electric fields

(c) In an electromagnetic wave, the phase difference between electric and magnetic field vectors $\vec{E}$ and $\vec{B}$ is

(i) 0 (ii) $\frac{\pi}{2}$

(iii) $\pi$ (iv) $\frac{\pi}{4}$

(d) The degree of polarization for ordinary light reflected from a plane interface is

(i) $\frac{R_{\|} - R_{\perp}}{R_{\perp} + R_{\|}}$ (ii) $\frac{R_{\perp} - R_{\|}}{R_{\perp} + R_{\|}}$

(iii) $\frac{R_{\perp} + R_{\|}}{R_{\perp} - R_{\|}}$ (iv) $\frac{R_{\|} - R_{\perp}}{R_{\perp} - R_{\|}}$

where $R_{\|}$ and $R_{\perp}$ are parallel and perpendicular components of reflected light.

(e) The fringe-shift in Michelson-Morley experiment is given by

(i) $\Delta N = \dfrac{2lv^2}{c^2\lambda}$

(ii) $\Delta N = \dfrac{2l^2v^2}{c^2\lambda}$

(iii) $\Delta N = \dfrac{lv^2}{c^2\lambda}$

(iv) $\Delta N = \dfrac{2l}{c} \cdot \dfrac{v^2}{2c^3}$

(f) The ratio of electrostatic and magnetic energy densities is given by

(i) $\dfrac{u_0}{u_m} = \dfrac{\frac{1}{2}\varepsilon_0 E^2}{\frac{1}{2}\mu_0 H^2} = 1$

(ii) $\dfrac{u_0}{u_m} = \dfrac{\frac{1}{2}\varepsilon_0 E^2}{\frac{1}{2}\mu_0 H^2} = -1$

(iii) $\dfrac{u_0}{u_m} = \dfrac{\frac{1}{2}\varepsilon_0 E^2}{\frac{1}{2}\mu_0 H^2} > 1$

(iv) $\dfrac{u_0}{u_m} = \dfrac{\frac{1}{2}\varepsilon_0 E^2}{\frac{1}{2}\mu_0 H^2} < 1$

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

(a) Establish Maxwell's third equation in differential form.

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

(c) Explain what you mean by skin effect.

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

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

where $\theta_B$ is the Brewster's angle, $n_1$ and $n_2$ are the refractive indices of the media.

(e) What is time dilation in relativistic mechanics?

(f) Discuss the phenomenon of total internal reflection of electromagnetic waves.

(g) Show that time rate of change of dipole moment of an oscillating dipole is equal to the current element ($I\,dl$), i.e., $\dot{P} = I\,dl$. Discuss the mechanism of electromagnetic radiations from a dipole.

**3.** Write Maxwell's wave equations in terms of scalar and vector potentials. Show that these equations are invariant under Lorentz gauge transformation.

4. Discuss the propagation of plane electromagnetic waves in isotropic dielectric medium and hence show that $\vec{E}$, $\vec{H}$ and $\vec{K}$ are perpendicular to each other. ($\vec{K} \rightarrow$ propagation vector) 5

5. What is Poynting vector? How is the Poynting vector calculated on the surface of the sun? 2+2=4

*Or*

Show that total power radiated by an accelerated charge at low velocity is

$$P = \frac{e^2 a^2}{6\pi\varepsilon_0 c^3}$$

where the symbols have their usual meanings. 4

6. *(a)* Discuss the phenomenon of polarization of electromagnetic waves. 5

*(b)* Obtain the boundary conditions satisfied by electromagnetic field vectors $\vec{B}$ and $\vec{H}$ on a plane surface between two media. 6

7. Derive Lorentz transformation equations. 6

*Or*

Explain Einstein's postulates of special theory of relativity.

8. *(a)* The length of a rocket ship is 100 metres on the ground. When it is in flight, its length observed on the ground is 99 metres. Calculate its speed. 3

*(b)* Explain in brief the nullity of ether hypothesis. 5

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