SET A

M.Sc. PHYSICS
FIRST SEMESTER
ELECTRODYNAMICS
MSP – 104

[USE OMR FOR OBJECTIVE PART]

Duration: 1:30 hrs. **Full Marks: 35**

(Objective)

Time: 15 mins. **Marks: 10**

Choose the correct answer from the following: ***1×10=10***

1. Which one of the following Maxwell's equations implies the absence of magnetic monopoles?
   a. $\nabla . E = \rho/\epsilon_o$
   b. $\nabla . B = 0$
   c. $\nabla \times E = -\partial B/\partial t$
   d. $\nabla \times B = (\frac{1}{c^2})\ \partial B/\partial t + \mu_o J$

2. The gauge transformation of the scalar and vector potentials that leave the electric and magnetic field invariant are:
   a. $\vec{A} \rightarrow \vec{A'} = A - \frac{\partial \lambda}{\partial t}$, $V \rightarrow V' = V + \nabla\lambda$
   b. $\vec{A} \rightarrow \vec{A'} = A + \nabla\lambda$, $V \rightarrow V' = V - \frac{\partial \lambda}{\partial t}$
   c. $\vec{A} \rightarrow \vec{A'} = A - \nabla\lambda$, $V \rightarrow V' = V - \frac{\partial \lambda}{\partial t}$
   d. $\vec{A} \rightarrow \vec{A'} = A + \nabla\lambda$, $V \rightarrow V' = V + \frac{\partial \lambda}{\partial t}$

3. An electro-magnetic field is defined by a scalar potential $V(\vec{r}, t) = 0$ and vector potential $\vec{A}(\vec{r}, t) = \frac{1}{4\pi\epsilon_o}\frac{qt}{r^2}\hat{r}$. The corresponding electric field is:
   a. $\vec{E} = 0$
   b. $\vec{E} = \frac{1}{4\pi\epsilon_o}\frac{q}{r^2}\hat{r}$
   c. $\vec{E} = -\frac{1}{4\pi\epsilon_o}\frac{q}{r^2}\hat{r}$
   d. $\vec{E} = \frac{1}{4\pi\epsilon_o}\frac{q}{r^2}\hat{\theta}$

4. For a medium of electric and magnetic field, the relation between E and B with propagation vector k is:
   a. $\vec{E} \times \vec{k} = \omega\vec{B}$
   b. $\vec{E} \times \vec{k} = \vec{\omega} \times \vec{B}$
   c. $\vec{E} = \frac{k}{\omega} \times \vec{B}$
   d. $\vec{B} = \frac{\vec{k} \times \vec{E}}{\omega}$

5. Current flowing in a circuit containing a capacitor, to satisfy the continuity equation $\vec{\nabla} . \vec{J} = -\frac{\partial \rho}{\partial t}$, for charge and current, the current density $\vec{J}$ must be replaced by
   a. $\epsilon_o \frac{\partial \vec{E}}{\partial t}$
   b. $\vec{J} - \epsilon_o \frac{\partial \vec{E}}{\partial t}$
   c. $\vec{E} - \epsilon_o \frac{\partial \vec{J}}{\partial t}$
   d. $\vec{J} + \epsilon_o \frac{\partial \vec{E}}{\partial t}$

6. If electric field $\vec{E}=E\hat{x}$ and magnetic field $\vec{B}=B\hat{y}$, then the Poynting vector can be expressed as:
   a. $\vec{S} = \epsilon_o E^2 \hat{z}$
   b. $\vec{S} = c\epsilon_o E^2 \hat{z}$
   c. $\vec{S} = c\epsilon_o E^2 \hat{y}$
   d. $\vec{S} = c\epsilon_o E^2 \hat{x}$

7. What should be the velocity of a charge particle moving through a velocity selector? (V, B and E represent the velocity, magnetic field and electric field intensities respectively)
   a. V=B/E
   b. V=E/B
   c. V= EB
   d. None of above

8. Which of the following parameter is invariant under Lorentz transformation?
   a. $\vec{E}.\vec{B}$
   b. $\vec{E}.\vec{A}$
   c. $\vec{E}.\vec{M}$
   d. $\vec{E}.\vec{P}$

9. Fo accelerated charge particle; the electric field (E) varies with distance r is
   a. $E \propto \frac{1}{r^3}$
   b. $E \propto \frac{1}{r^4}$
   c. $E \propto \frac{1}{r}$
   d. $E \propto \frac{1}{r^2}$

10. The medium used in Michelson-Morley experiment is
   a. Aether
   b. Water
   c. Glass
   d. Gas

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Descriptive

Time : 1 hr. 15 mins. **Marks: 25**

[Answer question no.1 & any two (2) from the rest]

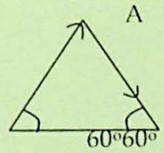
1. State maxwell's electromagnetic equations for free space and henceprove that the velocity of an electromagnetic wave is equal to the speed of light. **2+3=5**

2. The electric field of an electromagnetic wave is given by $\vec{E} = (10\hat{y} + 5\hat{z})cos\ [\omega t + (2y - 4z)]$. Find (i) k, (ii) ω, (iii) $\vec{B}$ and (iv) J_d (the symbols have their usual meanings) **2+2+4+2 =10**

3. Using the Lorentz gauge condition $\nabla . A + \mu_o \epsilon_o \frac{\partial V}{\partial t} = 0$, prove that $\square^2 V = -\frac{\rho}{\epsilon_O}$ and $\square^2 A = -\mu_o J$ **5+5= 10**

4. An infinite straight wire carries current I (t)= 0 for t≤ 0
   $= I_o$ for t> 0
   Find the retarded vector potential and electric field at a distance s from the wire. **5+5=10**

5. State the Lorentz transformation equations in special theory of relativity. Two persons A and B are moving with equal speed c/2 as shown in the figure. What is the velocity of B with respect to A? **4+6=10**



c/2 c/2

B C

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