This question paper contains 4 printed pages]

11/12/19 E

Roll No. | | | | | | | | | | | |

S. No. of Question Paper : **8529**

Unique Paper Code : **32225101** **J**

Name of the Paper : **Electricity and Magnetism**

Name of the Course : **Physics : GE. for Honours**

Semester : **I**

Duration : **3 Hours** Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt any *five* questions.

Q. No. **1** is compulsory.

All questions carry equal marks.

1. Attempt any *five* of the following : 5×3=15

(*a*) Determine the constant a, so that the vector $\vec{A} = (x+3y)\hat{i} + (2y+3z)\hat{j} + (x+az)\hat{k}$ is solenoidal.

(*b*) Explain the physical significance of divergence and curl of a vector function.

(*c*) Can the following be a possible electrostatic field ?

$$\vec{E} = xy\hat{i} + 2yz\hat{j} + 3xz\hat{k}$$

P.T.O.

(*d*) Three point charges $+q$, $+2q$ and $-4q$ are located at the three corners of an equilateral triangle of side a. Calculate the electric potential energy of this discrete charge configuration where $q = 1.0 \times 10^{-7}$ C and $a = 10$ cm.

(*e*) Distinguish between dia-, para- and ferro-magnetic materials.

(*f*) Discuss the difference between induced electric field and electric field due to static charges.

(*g*) A current of 30 A flows in a flat circular coil having 100 closely wound turns of radius 10 cm. What is the magnetic flux density at the centre of the coil ?

2. (*a*) Show that $\mathbf{V}(x, y, z) = 2xyz\mathbf{i} + (x^2z + 2y)\mathbf{j} + x^2y\mathbf{k}$ is irrotational and find a scalar function $U(x, y, z)$ such that $\mathbf{V} = \nabla U$.

(*b*) Find a unit vector normal to the surface $x^2y + 2xz = 4$ at the point $(2, 1, -3)$. 9, 6

3. (*a*) Find the electric potential due to an electric dipole at a point P having distance $\vec{r}$ and angle θ from the centre of the dipole.

(*b*) If the earth has a surface charge density equal to the charge of an electron, calculate the potential on the surface of the earth. Also find the electric field just outside the earth. ($e = 1.6 \times 10^{-19}$ C, radius of earth $= 6 \times 10^6$ m). 8,7

4. (*a*) Using Gauss's law find the electric field inside and outside a solid sphere carrying a uniform volume charge density of ρ.

(*b*) Evaluate the electrostatic energy of a uniformly charged sphere and show that it is 6/5 times the energy of a conducting sphere having the same amount of charge and the same radius. 7, 8

5. (*a*) Using Biot-Savart's law, find the magnetic field at the centre of a current (I) carrying circular coil of radius a.

(*b*) Using Ampere's circuital law, find the magnetic field due to a current (I) carrying long cylindrical wire of radius R at a point distant r from the axis of the cylindrical wire for $r > R$ and $r < R$. 8, 7

6. (*a*) State and prove reciprocity theorem for mutual inductance (i.e. $M_{12} = M_{21}$).

(*b*) Calculate the mutual inductance of solenoid of 1 m length having 1000 turns in primary and 200 turns in secondary. The area of cross-section of solenoid is 5 cm^2. 8,7

7. (*a*) Define magnetic vector potential $\vec{A}$ and derive the expression : $\vec{A} = \frac{\mu_0}{4\pi}\int \frac{\vec{J}}{r} d\tau$.

(*b*) Explain how and under what conditions the Ampere's circuital law was modified by Maxwell. 8,7