Set C

Unique Paper Code	:	42221201
Name of the Paper	:	Electricity, Magnetism and EMT
Name of the Course	:	B. Sc. Prog – CBCS – Core II
Semester	:	2 hours
Duration	:	75
Maximum Marks	:	

Instructions for Candidates

Attempt any **four** questions.

All questions carry equal marks.

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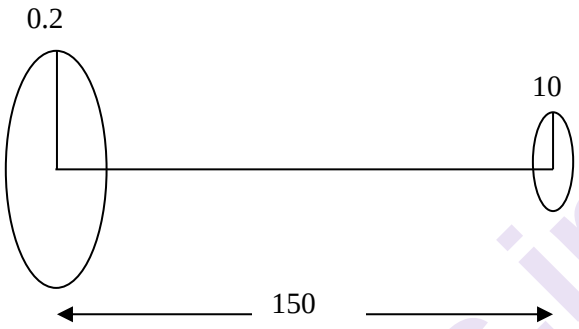
1. What do you understand by rotational and irrotational fields? Is the vector field $\vec{V} = (x^2 - y^2 + x)\hat{\imath} - (2xy + y)\hat{\jmath}$ irrotational? If yes, then find its scalar potential.

2. Explain (i) density of electric field lines, (ii) flux, and (iii) the relationship between electric field and field lines at a given point. A sphere carries charge density $\rho = \frac{k}{r^2}$ in the region $a \leq r \leq b$. Find the electric field in three regions (i) $a < r$, (ii) $a \leq r \geq b$, (iii) $r > b$. Plot $\overrightarrow{|E|}$ as a function of *r*.

3. What do you understand by free charges, bound charges and electric polarisation? Define electric displacement ***D*** and derive Gauss's law in a linear dielectric. Consider a parallel plate capacitor with capacitance C connected to a source of potential V. The volume between plates is filled with material with dielectric constant K. Find charges on capacitor plates, and induced charges on the surfaces of the dielectric facing capacitor plates. What are ***E***, ***P*** and ***D***? Show their directions in a diagram.

4. State Biot Savart's law and use it to find the magnetic field at the center of a square loop of sides *s* and carrying current *I*. Discuss different physical origins of dia, para and ferromagnetic properties. Comment on the statement that para and ferro magnetic materials too have diamagnetism, but it is masked by of para and ferromagnetic effects.

5. Find the amount of work done in establishing current *I* in an inductor of self-inductance *L*. In what form does this work appear once the current has been established. A small circular loop of radius 10 mm lies parallel to a big circular loop of radius 0.2 m with its centre on the axis of the big loop, as shown in the diagram below. The big loop carries 2 A current and the distance between the centres of the two loops is 150 mm. Calculate the flux linked with the small circular loop and the mutual inductance of the two coils.



6. Discuss the inconsistency in Ampere's circuital law. How did Maxwell remove this inconsistency by introducing 'displacement current' $J_d \equiv \epsilon_0 \frac{\partial E}{\partial t}$? Show that the displacement current in the region between plates of a parallel plate capacitor is equal to the conduction current in connecting wires.

Useful Constants

$\epsilon_0 = 8.85 \times 10^{-12} \mathrm{C^2 N^{-1} m^{-2}}$

$\mu_0 = 4\pi \times 10^{-7} \mathrm{N A^{-2}}$