INDIAN INSTITUTE OF TECHNOLOGY MADRAS
PH1020
Tutorial-5

Question 1:-

The vector potential in a region is given by $\vec{A}(\rho,\phi,z) = -\frac{\mu_0}{2}k\rho^2\,\hat{e}_z$ for $0 < \rho \leq a$ and $-\frac{\mu_0}{2}ka(2\rho - a)\hat{e}_z$ for $\rho > a$. Find the corresponding $\vec{J}$ and sketch its magnitude as a function of ρ.

Question 2:-

(a) Find the vector potential due to an infinite wire carrying a steady current 'I' along z- axis. Using the following relations:

$$(i)\ \ \vec{A} = \frac{\mu_0}{4\pi}\int \frac{I}{r}\,\overrightarrow{dl'} \quad (ii)\ \ \vec{B} = \vec{\nabla}\times\vec{A}.$$

Analyse the results obtained from both the relations.

(b) Now bring a second infinite straight wire with steady current I and aligned it parallel to the first wire at a distance d. Calculate the vector potential when both the wires have (i) parallel currents (ii) anti-parallel currents.

Question 3:-

Find the vector potential above and below the current sheet, lies in the XY-plane, with uniform current density $\vec{K} = k\hat{x}$. Also verify the magneto-static boundary condition for the vector potential.

Question 4:-

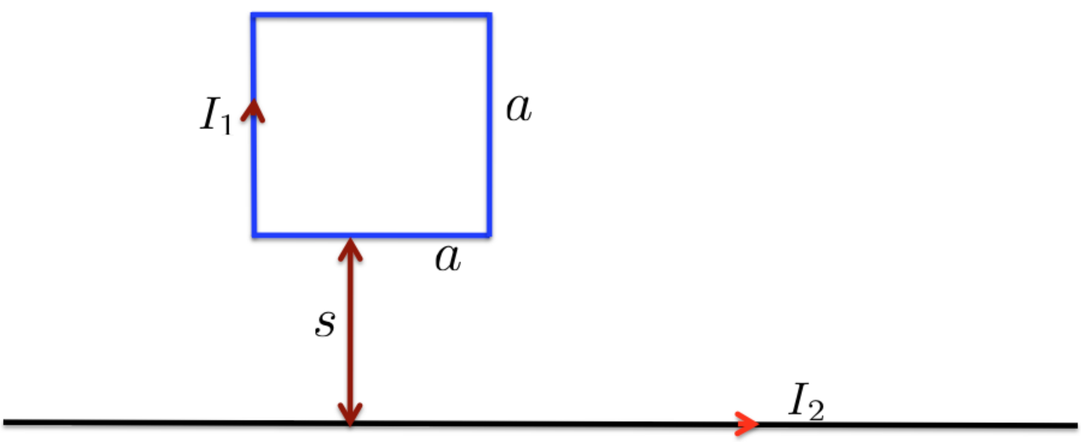
A loop of dimensions $a \times a$, carrying a steady current I_1, is placed at a distance s from an infinite wire carrying a steady current I_2, as shown in the figure.

(i) Calculate the total force exerted on the loop by the wire.

(ii) Assuming $a << s$, where the loop can be approximated as a point magnetic dipole. Using this approximation calculate:

a) Force on the loop using the expression $\vec{\nabla}(\vec{m}.\vec{B})$.

b) Force on the wire due to the loop.



Question 5:-

Find the force of attraction between two magnetic dipoles, m_1 and m_2, oriented as shown in figure, a distance ‘r’ apart.