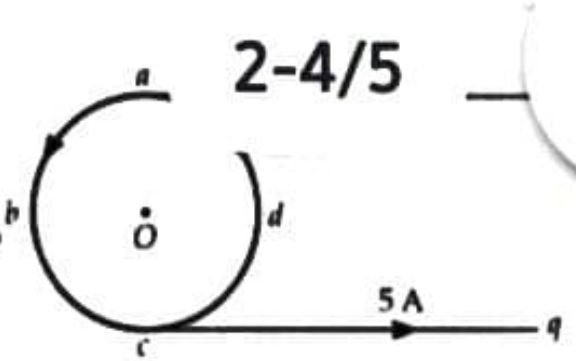
HOME ASSIGNMENT

2-4/5

Question1: In figure abcd is a circular coil of the non-insulated thin uniform conductor. Conductors pa and qc are very long straight parallel conductors tangential to the coil at the points a and c. If a current of 5 A enters the coil from P to a, find the magnetic induction at O, the center of the coil. The diameter of the coil is 10cm.



2-7-21

Ans 1. Current in bcd : Current in bfd

$r = 5\text{ cm} = 5\times10^{-2}\text{ m}$

Magnetic field induction at O due to current through circular coil is O.

Magnetic field induction at O due to current through straight conductor ab

$$B_1 = \frac{\mu_0 I}{4\pi r}(\sin 90^\circ + \sin 0^\circ) = 10^{-7}\times\frac{5}{5\times10^{-2}} = 10^{-5}\text{ T}$$

outward to plane of page

Magnetic field induction at O due to current through st. conductor de

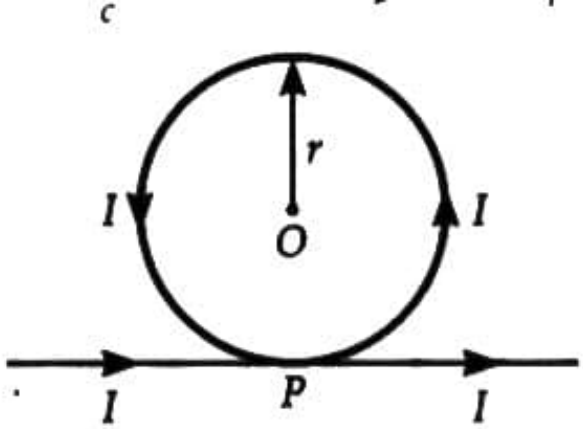
$$B_2 = \frac{\mu_0 I}{4\pi r}(\sin 90^\circ + \sin 0^\circ) = 10^{-7}\times\frac{5}{5\times10^{-2}} = 10^{-5}\text{ T}$$

outward to plane of page

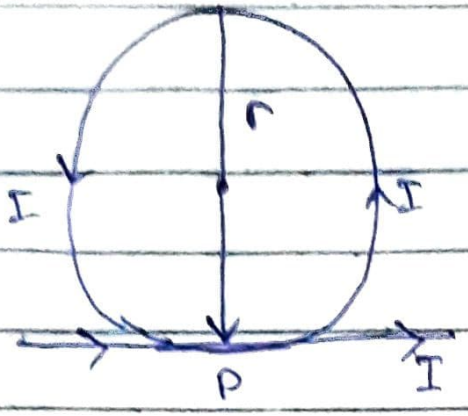
$B = B_1 + B_2 = 10^{-5} + 10^{-5} = 2\times10^{-5}\text{ T}$ normal to the plane of page and outwards.

coil is 10cm.

Question2: A long wire is bent as shown in the figure. What will be the magnitude and direction of the field at the center O of the circular portion, if a current I is passed through the wire? Assume that the various portions of the wire do not touch at point P



Ans d:



$B_{st.line\ current} = \frac{\mu_0 I}{2\pi r}$ outward to page

$B_{circular\ current} = \frac{\mu_0 I}{2r}$ outward to page

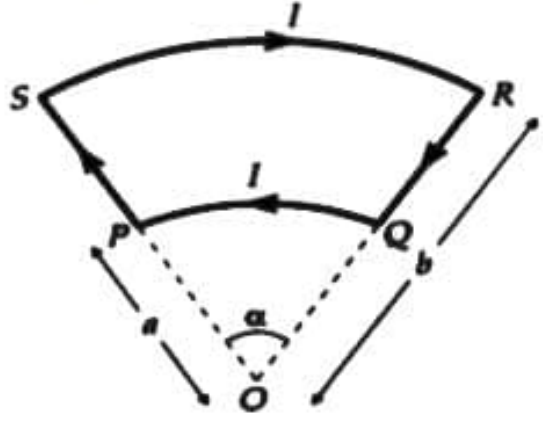
$B_{net} = \left(\frac{\mu_0 I}{2\pi r} + \frac{\mu_0 I}{2r}\right)$

$= \frac{\mu_0 I}{2\pi r} + \frac{\mu_0 I}{2r}$ outward to page

$= \frac{\mu_0 I}{2r}\left(\frac{1}{\pi} + 1\right)$

Numerical

Question3: Figure shows a current loop having two circular segments and joined by two radial lines. Find the magnetic field at the center O.



Ans 3: Magnetic field due to BA with b'

$$B_1 = \left(\frac{\theta}{2\pi}\right)\left(\frac{\mu_0 i}{2a}\right)$$ outward to page

Magnetic field due to DC

$$B_2 = \left(\frac{\theta}{2\pi}\right)\left(\frac{\mu_0 i}{2a}\right)$$ inward to page

$\therefore$ Resultant $(\vec{B}) = \vec{B_1} - \vec{B_2}$

$$= \frac{\mu_0 i \theta (b-a)}{4\pi ab}$$ outward to page

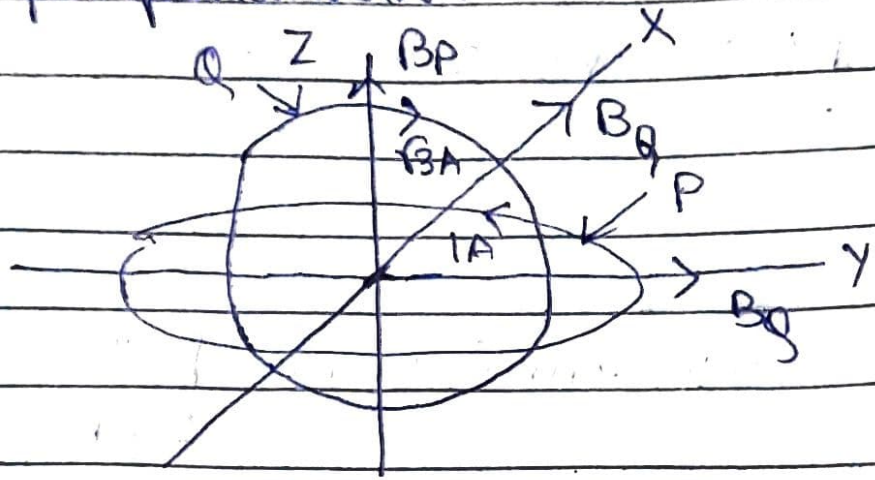
Question4: Two identical circular coils, P and Q each of radius R, carrying currents $1A$ and $\sqrt{3}A$ respectively, are placed concentrically and perpendicular to each other lying in the XY and YZ planes. Find the magnitude and direction of the net magnetic field at the centre of the coils.

Ans 4: Loop Radius = R

$I_p = 1A$

$I_q = \sqrt{3}A$

for coils in xy and yz planes being mutually perpendicular.



$$B_p = \frac{\mu_0 I}{2\pi R} = \frac{\mu_0}{2\pi R}$$

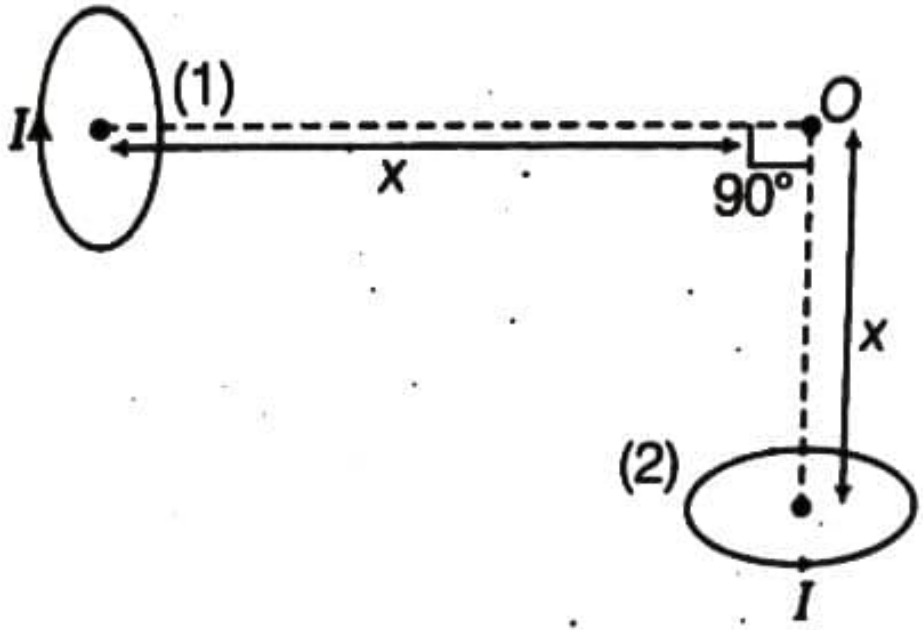
$$B_q = \frac{\mu_0 I}{2\pi R} = \frac{\mu_0 \sqrt{3}}{2\pi R}$$

$$B_{net} = \sqrt{B_p^2 + B_q^2}$$

$$= \sqrt{4}\,\frac{\mu_0}{2\pi R} = \frac{\mu_0}{\pi R}$$

Home Assignment

Question5: Two very small identical circular loop (1) and (2) carrying equal current I are placed vertically (with respect to the plane of the paper) with their geometrical axes perpendicular to each other as shown in the figure. Find the magnitude and direction of the net magnetic field produced at the point O.



Ans 5: We know, Magnetic field due to circular loop

$$= \mu_0 2\pi R^2 I / 4\pi (x^2 + R^2)^{3/2}$$

$$|\vec{B}| = \frac{\mu_0 R^2 I}{2(x^2 + R^2)^{3/2}}$$

$$|\vec{B}_{net}| = \sqrt{2}\,|\vec{B}| = \frac{\sqrt{2}\,\mu_0 R^2 I}{2(x^2+R^2)^{3/2}} \quad \text{along} \quad \frac{-\hat{i}-\hat{j}}{\sqrt{2}}$$