PHY 112

Final Exam

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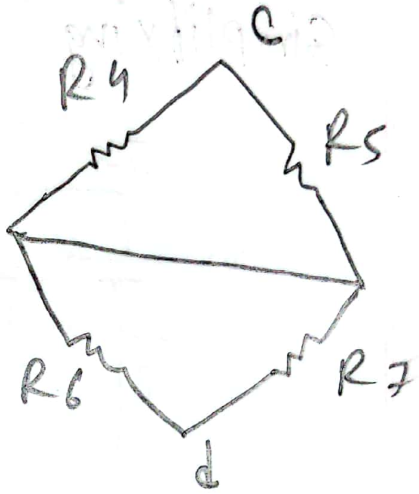
sec : 8 (TKT)

Ans to the Q no 1

Given,



$R_4 = 6\,k\Omega = 6\times10^3\,\Omega$

$R_5 = 4\,k\Omega = 4\times10^3\,\Omega$

$R_6 = 12\,k\Omega = 12\times10^3\,\Omega$

$R_7 = 12\,k\Omega = 12\times10^3\,\Omega$

Here, $R_4 \parallel R_5 = \dfrac{1}{\left(\frac{1}{6}+\frac{1}{4}\right)} = 2.4\times10^3\,\Omega$

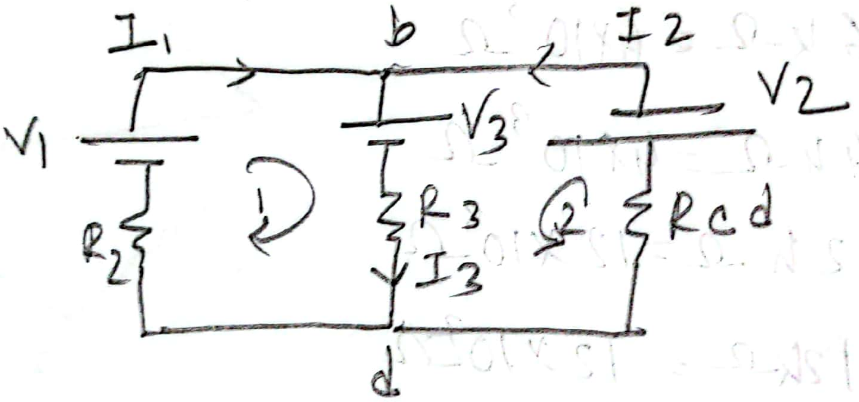
$R_6 \parallel R_7 = \dfrac{1}{\left(\frac{1}{12}+\frac{1}{12}\right)} = 6\,k\Omega = 6\times10^3\,\Omega$

$\therefore$ Resistance across cd,

$R_{cd} = (2.4+6) = 8.4\,k\Omega = 8.4\times10^3\,\Omega$

b

Simplifying the diagram we get,



Applying KCL at b node,

$I_1 + I_2 = I_3$ --- (1)

Applying KVL :

Loop 1 : $V_3 + I_3 R_3 + I_1 R_1 - V_1 = 0$ --- (11)

Loop 2 : $-V_2 - I_2 R_{cd} - I_3 R_3 - V_3 = 0$ — (111)

Loop-3 : $-V_2 - I_2 R_{cd} + I_1 R_2 - V_1 = 0$ — (1V)

C

using (I) and (III) from b,

$$V_1 - V_3 = I_1 R_2 + (I_1 + I_2) R_3$$

$$\Rightarrow 1 = 6 I_1 + 6 (I_1 + I_2)$$

$$\Rightarrow 2I_1 + I_2 = \frac{1}{6} \quad \cdots (V)$$

using (I) and (III),

$$V_2 + V_3 + I_2 R_{cd} + (I_1 + I_2) R_3 = 0$$

$$\Rightarrow 22 + I_2 (8.4) + 6 (I_1 + I_2) = 0$$

$$\Rightarrow 6 I_1 + 14.4 I_2 = -22 \quad \cdots (VI)$$

solving (V) and (VI),

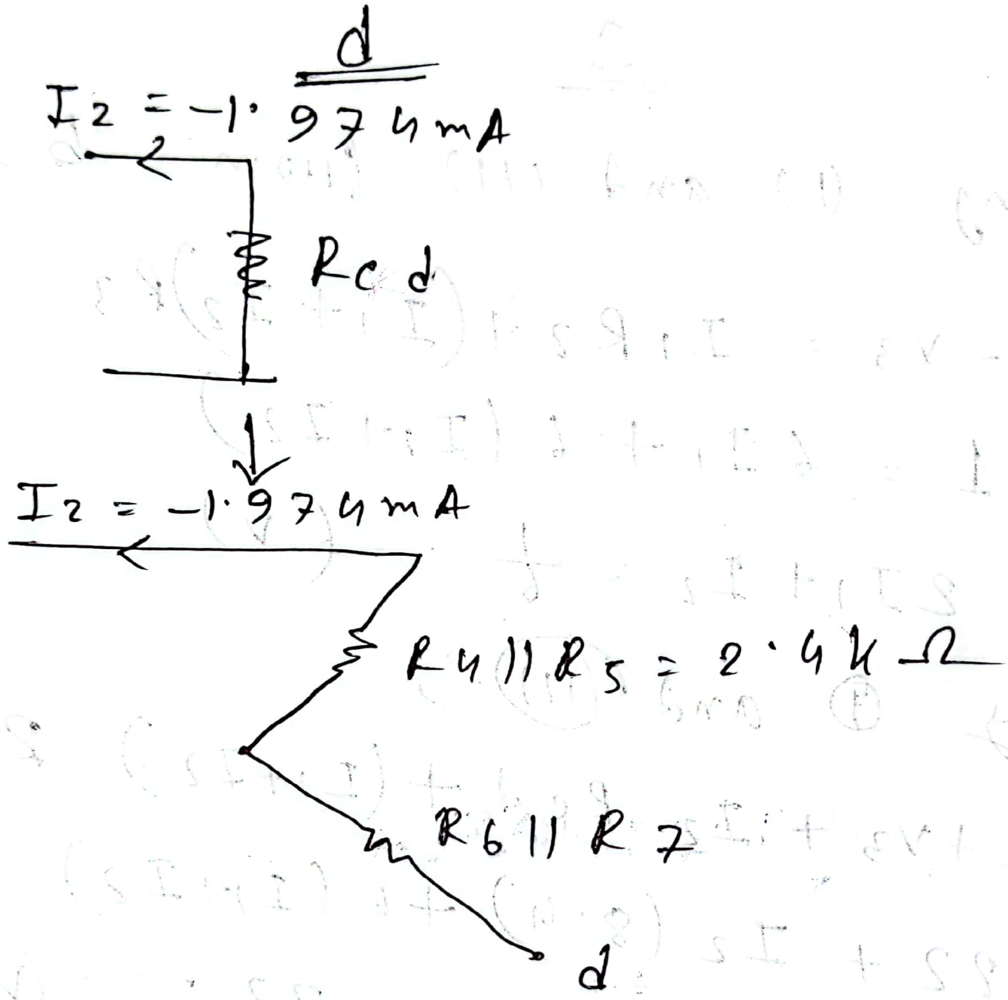
$$11.4 I_2 = -22 - 0.5$$

$$\therefore I_2 = \frac{-22.5}{11.4} = -1.974$$

$$\therefore I_1 = \left(\frac{1}{6} + 1.974\right) \times 0.5 = 1.07$$

current through R_3 is,

$$\therefore I_3 = -0.904 \text{ A}$$



Potential diffrence across R_4,

$$V = 1.974 \times 2.4$$
$$= 4.738 \ V$$

Ans to the qr no 3

a

Given, current, $i = 14 \times 10^{-3}$ A

radius, $r = 14 \times 10^{-3}$ m

magnetic field at point A due to wire 1,

$$\vec{B_1} = \frac{\mu_0 I}{2\pi R} \hat{k}$$

Due to wire 2, $\vec{B_2} = \frac{\mu_0 I}{2\pi R} \hat{k}$ (using right hand grip)

$$\therefore \vec{B_{net}} = \vec{B_1} + \vec{B_2}$$

$$= \frac{2 \mu_0 I}{2\pi R} \hat{k}$$

$$= \frac{12.56 \times 10^{-7} \times 14 \times 10^{-3}}{3.1416 \times 14 \times 10^{-3}}$$

$$= 3.9979 \times 10^{-7} \hat{k}$$

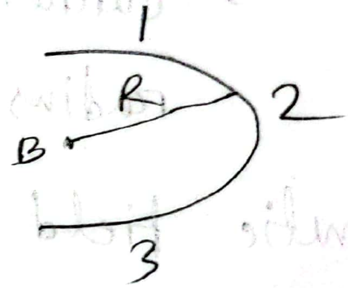
$\therefore$ x component 0 T

y component 0 T

z component 3.9979×10^{-7} T

(b)

Considering 3 portions as portion 1, 2, 3 net magnetic field at point B ;



$$\vec{B}_{net} = \vec{B}_1 + \vec{B}_2 + \vec{B}_3$$

$$= \frac{\mu_0 I}{4\pi R} + \frac{\mu_0 I \phi}{4\pi R} + \frac{\mu_0 I}{4\pi R}$$

$$= \frac{\mu_0 I}{4\pi R} (1+\pi+1)$$

$$= \frac{12.56 \times 10^{-7} \times 14 \times 10^{-3}}{4 \times 3.1416 \times 14 \times 10^{-3}} \times 5.141$$

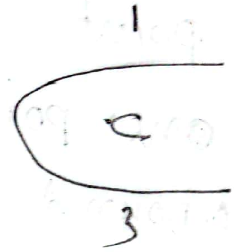
$$5.1383 \times 10^{-7}$$

$$=$$

$\therefore \vec{B}_{net}$ at point B 5.1383×10^{-7} T

C

Similar as point B, at point C there will be three portions.



Net magnetic field at point C will be,

$$\vec{B}_{net} = B_1 + B_2 + B_3$$

$$= \frac{\mu_0 I}{4\pi R}(1+\pi+1)$$

$$= \frac{12.56\times10^{-7}\times 14\times10^{-3}}{4\times3.1416\times14\times10^{-3}}\times 5.141$$

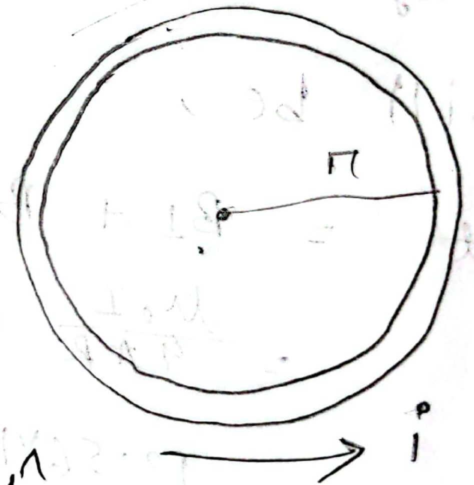
$$= 5.138\times10^{-7}\ T$$

d

If distance between C and B point becomes zero it turns into one point creating a circular path around d.

Here,

Dipole moment,



$\vec{\mu} = IA\hat{r}$

$= I \cdot (\pi r^2) \cdot \hat{k}$ (using right hand rule)

$= 19\times10^{-3} \times \pi \times (14\times10^{-3})^2 \cdot \hat{k}$

$= 8.6205\times10^{-6}$ Am^2 $\hat{k}$

Ans to the qr no 9

a

Given, $I_1 = 9 \times 10^{-3}$ A

radius, $R = 12 \times 10^{-2}$ m

Point which we have to find B is,

$r_1 = 10 \times 10^{-2}$ m

since, $r_1 < R$,

$$\vec{B} = \frac{\mu_0 J r_1}{2}$$

$$= \frac{12.56 \times 10^{-7} \times 0.1989 \times 10 \times 10^{-2}}{2}$$

$$= 1.2493 \times 10^{-8} \text{ T}$$

$$J = \frac{I}{A} = \frac{I}{\pi R^2}$$

$$= \frac{9 \times 10^{-3}}{\pi \times (12 \times 10^{-2})^2}$$

$$= 0.1989$$

$\therefore$ B at point r_1 is 1.2493×10^{-8} T

b

New point is $r_2 = 14 \times 10^{-2}$ m

since, $r_2 > R$,

$$B = \frac{\mu_0 J R^2}{2 r_2}$$

Here,
$J = 0.1989$
from (a)

$$= \frac{\cancel{1}2.56 \times 10^{-7} \times 0.1989 \times (12 \times 10^{-2})^2}{2 \times 14 \times 10^{-2}}$$

$$= 1.2847 \times 10^{-8} \text{ T}$$

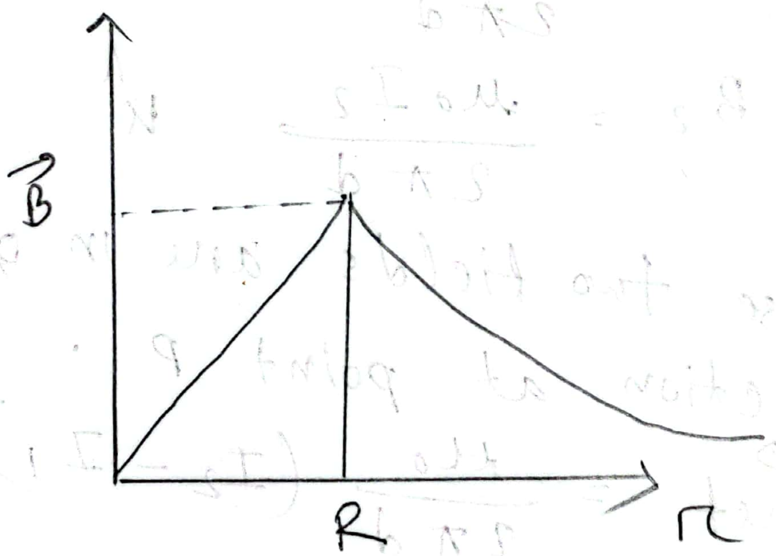
$\therefore$ magnetic field at point r_2 is
1.2847×10^{-8} T

C

when, $r_1 < R$, $\vec{B} = \frac{\mu_0 J}{2} r_1$

$r_2 > R$, $\vec{B} = \frac{\mu_0 J R^2}{2} \cdot \frac{1}{r_2}$

$B(r)$ vs, r diagram:



d

Given, $I_2 = -16 \times 10^{-3}$ A

$R_2 = \frac{d}{2} = \frac{42}{2} = 21 \times 10^{-2}$ m

Magnetic field due to I_1 :

$$B_1 = \frac{\mu_0 I_1}{2\pi d} (-\hat{k})$$

$$B_2 = \frac{\mu_0 I_2}{2\pi d} \hat{k}$$

These two fields are in opposite direction at point P.

$$\therefore \vec{B}_{net} = \frac{\mu_0}{2\pi d} (I_2 - I_1)$$

$$= \frac{12.56 \times 10^{-7}}{2\pi \times 42 \times 10^{-2}} (16-9) \times 10^{-3}$$

$$= \frac{7 \times 10^{-8}}{42}$$

$$= \frac{1}{6} \times 10^{-6}$$

$$= 1.667 \times 10^{-9} \text{ T}$$