PHY112

SPECIAL GRADED ASSESSMENT
03

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SECTION-04

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PHY 112 _ Section-04

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Ans. To The Q. No. (3.1)

(a)

$$E = I * R_1 + \frac{Q_1}{C_1} + \frac{Q_2}{C_2}$$

(b)

Given,

$C_1 = 1.1\,\mu F = 1.1 \times 10^{-6}\,F$

$C_2 = 8.8\,\mu F = 8.8 \times 10^{-6}\,F$

$R_1 = 2.2\,k\Omega = 2.2 \times 10^{3}\,\Omega$

Equivalent Capacitance, $C = \frac{C_1 \times C_2}{C_1 + C_2}$

$= \frac{1.1 \times 10^{-6} \times 8.8 \times 10^{-6}}{1.1 \times 10^{-6} + 8.8 \times 10^{-6}}$

$= 9.78 \times 10^{-7}\,F$

Time constant, $\tau = C R_1$

$= 9.78 \times 10^{-7} \times 2.2 \times 10^{3}$

$= 2.15 \times 10^{-3}\,s$

$= 2.15\,ms$ (Ans)

(c)

Here,

$C_2 = 8.8 \times 10^{-6} F$ $\quad$ $E = 14 V$

$t = 1.2 T$ $\quad$ $C = 9.78 \times 10^{-7}$

We know,

$$Q(t) = Q_0 \left(1 - e^{-\frac{t}{T}}\right)$$

$$\therefore Q(1.2) = CE\left(1 - e^{-\frac{1.2T}{T}}\right)$$

$$= 9.78 \times 10^{-7} \times 14 \left(1 - e^{-1.2}\right)$$

$$= 9.5659 \times 10^{-6} C$$

$$= 9.5659 \ \mu C$$

(Ans)

(d)

Here,

$t = 10 T$ sec

we know,

$$Q(10) = CE\left(1 - e^{-10}\right)$$

$$= 9.78 \times 10^{-7} \times 14 \left(1 - e^{-10}\right)$$

$$= 1.3288 \times 10^{-5} C$$

$$= 13.688 \ \mu C$$

(Ans)

(e)

Here,

$t' = 1.9T$, $E = 14\,V$, $R_2 = 33 \times 10^3\,\Omega$

We know,

$$E(t') = E\left(e^{-\frac{1.9T}{T}}\right)$$

$$\Rightarrow E(1.9T) = 14 \times e^{-1.9}$$

$$\therefore E = 2.09$$

Now,

$$E = IR$$

$$\Rightarrow I_2 R_2 = E.$$

$$\Rightarrow I_2 = \frac{E.}{R_2} = \frac{2.09}{33 \times 10^3}$$

$$= 6.345 \times 10^{-5}\,A$$

$$= 6.346 \times 10^{-2}\,mA$$

(Ans)

(f)

Here,

$t' = 0$, $C_2 = 8.8 \times 10^{-6} F$, $R_2 = 33 \times 10^3 \Omega$

We know,

$$Q(t) = Q_0 e^{-\frac{t'}{C_2 R_2}}$$

$$\Rightarrow \frac{Q_2}{2} = Q_0 e^{-\frac{t'}{C_2 R_2}}$$

$$\Rightarrow 2 = e^{-\frac{t'}{C_2 R_2}}$$

$$\Rightarrow \frac{t'}{C_2 R_2} = \ln(2)$$

$$\Rightarrow t' = \ln 2 \times C_2 R_2$$

$$= \ln(2) \times 8.8 \times 10^{-6} \times 33 \times 10^3$$

$$= 0.201289 \text{ s}$$

$$= 201.289 \text{ ms}$$

(Ans)

Ans. To The Q. No. (3.2)

(a)

x component of the magnetic field = 0 T

(Ans)

y component of the magnetic field = 0 T

(Ans)

Here,

$N = 479$, $I_A = 59\,mA = 0.059\,A$

$l = 0.37\,m$

$\therefore$ z component of the magnetic

$$\text{field} = \frac{\mu_0 N I_A}{l} = \frac{4\pi \times 10^{-7} \times 479 \times 0.059}{0.37}$$

$$= 9.598 \times 10^{-5}\ T$$

(Ans)

(b)

Here,

$N = 479$, $I_B = 0.045\,A$, $l = 0.37\,m$

We know,

$$z \cdot \text{component for solenoid} = \frac{\mu_0 N I_B}{l}$$

$$= \frac{4\pi \times 10^{-7} \times 479 \times 0.054}{0.37}$$

$$= 8.7849 \times 10^{-5}\,T$$

$$\therefore \text{Net Magnetic field} = 9.599 \times 10^{-5} + 8.7849 \times 10^{-5}$$

$$= 1.83829 \times 10^{-4}\,T$$

(Ans)

$\therefore$ y component $= 0\,T$

(Ans)

(c)

Here,

$$\vec{\mu} = ((-30)\hat{i} + (-43)\hat{k}) \text{ Nm/T}$$

$$\vec{B} = (0)\hat{i} + (0)\hat{j} + (1.83829\times10^{-4})\hat{k}$$

We know,

$$\tau = \vec{\mu} \times \vec{B}$$

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -30 & 0 & -43 \\ 0 & 0 & 1.83829\times10^{-4} \end{vmatrix}$$

$$= -\hat{j}\,(-30\times1.83829\times10^{-4})$$

$\therefore$ y component $= 5.51487\times10^{-3}$ N m (Ans)

$\therefore$ x component $= 0$ N m (Ans)

$\therefore$ z component $= 0$ N m (Ans)

We know,

$$\cos\theta = \frac{\vec{\mu} \cdot \vec{B}}{|\vec{\mu}|\ |\vec{B}|}$$

$$= \frac{(-30)\hat{i} + (0)\hat{j} + (-43)\hat{k}\ (0\hat{i} + 0\hat{j} + 1.83829 \times 10^{-4}\hat{k})}{\sqrt{(-30)^2 + 0^2 + (-43)^2} \times \sqrt{0^2 + 0^2 + (1.83829 \times 10^{-4})^2}}$$

$$= \frac{-7.904247 \times 10^{-3}}{52.431 \times 1.83829 \times 10^{-4}}$$

$$= -0.82$$

$$\theta = \cos^{-1}(0.82)$$

$$\therefore \theta = 34.915^\circ$$

(Ans)

(d)

Here,

$I_A \rightarrow -I_A = -59\ mA$

$= -0.059\ A$

$I_B \rightarrow -I_B = -45\ mA$

$= -0.045\ A$

$l = 0.37m$

$N = 479$

We know,

$$B = \frac{\mu_0 N I_A}{l} \text{ for } I_A$$

$$B = \frac{\mu_0 N I_B}{l} \text{ for } I_B$$

when I_A,

z component $= -9.598 \times 10^{-5}$ T

x component $= 0$ T

when I_B,

z component $= -7.321 \times 10^{-5}$ T

x component $= 0$ T

$\therefore$ Net magntic field for z component

$= (-9.598 \times 10^{-5} + (-7.321 \times 10^{-5}))$T

$= -1.692 \times 10^{-4}$ T (Ans)

z component = 0 T (Ans)

(e)

Here,

$\vec{\mu} = (-30)\hat{i} + (-43)\hat{j}$

$\vec{B} = (-1.692 \times 10^{-4})\hat{k}$

We know,

$\tau = \vec{\mu} \times \vec{B}$

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -30 & 0 & -43 \\ 0 & 0 & -1.692\times10^{-4} \end{vmatrix}$$

$= -\hat{j}(-30 \times -1.692 \times 10^{-4})$

$= -5.0756 \times 10^{-3}$ Nm (Ans)

$\therefore$ x component = 0 Nm (Ans)

$\therefore$ z component = 0 Nm (Ans)

Ans. To The Q. No. (3.3)

(a)

Here,

$a = 20\,cm$

$= 0.2\,m$

$c = 3\ A/m^2$

$r = (0.7a) = (0.7 \times 0.2)\,m$

$= 0.14\,m$

$J = c\,\dfrac{r^2}{a^2}$

$= \dfrac{3 \times (0.14)^2}{0.2^2}$

$= 1.47$

$A = \pi a^2$

$= 3.1416\,(0.2)^2$

$= 0.125664\,m^2$

We know,

$I = JA$

$= 1.47 \times 0.125664$

$= 0.184726\ A$

$= 184.726\ mA$

(Ans)

(b)

Here,

$I = 184.726\ mA$

$= 0.184726\ A$ [from a]

$r = 0.7a = (0.7 \times 0.2)\ m$

$= 0.14\ m$

We know,

$\oint B \cdot dl = \mu_0 I$

$\Rightarrow B\, 2\pi r = \mu_0 I$

$\Rightarrow B = \frac{\mu_0 I}{2\pi r}$

$\Rightarrow B = \frac{4\pi \times 10^{-7} \times 0.184726}{2\pi \times 0.14}$

$\Rightarrow B = 2.6389 \times 10^{-7}\ T$

$\therefore B = 2.6389 \times 10^{-3}$ Gauss.

(Ans)

(c)

Here,

$$d = 79\ cm = 79 \times 10^{-2}\ m$$

$$a = 20 \times 10^{-2}\ m$$

$$J = c = 3$$

Enclosed current,

$$I = J\pi a^2$$

$$= 3\pi (20 \times 10^{-2})^2$$

$$= 0.3769\ A$$

We know,

$$B = \frac{\mu_0 I}{2\pi d}$$ [from Ampere's law]

$$= \frac{4\pi \times 10^{-7} \times 0.3269}{2\pi \times 79 \times 10^{-2}}$$

$$= 9.5441 \times 10^{-8}\ T$$

$$= 9.544 \times 10^{-4}\ Gauss$$

(Ans)

(d)

Perimeter of the loop $= 2\pi R = L$

Here,

$$L = 15\ cm = 15 \times 10^{-2}\ m$$

Now,

$$R = \frac{L}{2\pi} = \frac{15 \times 10^{-2}}{2\pi} = 0.02387$$

$$I = 0.3769\ A \quad [\text{from (c)}]$$

We know,

$$B = \frac{\mu_0 I}{2R} \quad [\text{from Biot-Savart Low}]$$

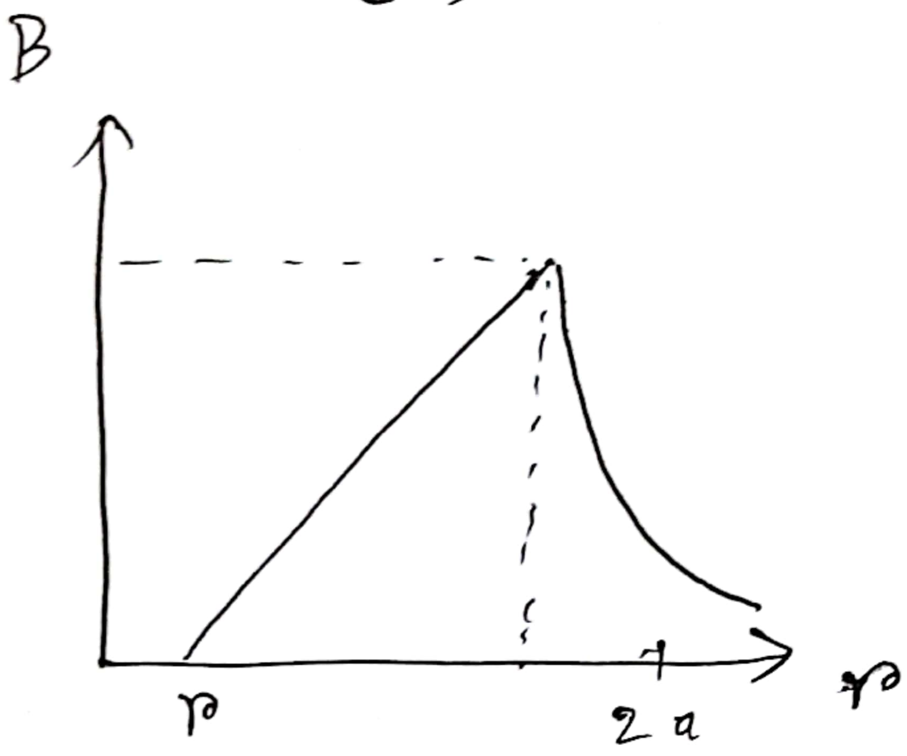
$$= \frac{4\pi \times 10^{-7} \times 0.3769}{2 \times 0.02387}$$

$$= 9.92 \times 10^{-6}\ T$$

$$\therefore B = 9.92 \times 10^{-2}\ \text{Gauss}$$

(Ans)

(e)



B vs r - Plot