PHY112

ASSIGNMENT-04

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SECTION-04

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Section - 04 Md. Shafkat Hasan

Ans. To The Q. No. (GA4.1)

Here,

$R_1 = 1.1\,k\Omega$	$R_4 = 2.2\,k\Omega$	$R_7 = 3.3\,k\Omega$
$R_2 = 2.2\,k\Omega$	$R_5 = 11\,k\Omega$	$R_8 = 3.3\,k\Omega$
$R_3 = 33\,k\Omega$	$R_6 = 3.3\,k\Omega$	$R_9 = 2.2\,k\Omega$

$E_1 = 8$ volts , $\mathcal{E}_2 = 2$ volts

a) $R_{bh} = R_9 \parallel R_7$

$$= \frac{R_9 \times R_7}{R_9 + R_7} = 1.32\,k\Omega$$

$R_{bk} = (R_5 + R_6) \parallel (R_{bh} + R_8)$

$$= \frac{(11+3.3)(1.32+3.3)}{(11+3.3)+(1.32+3.3)}$$

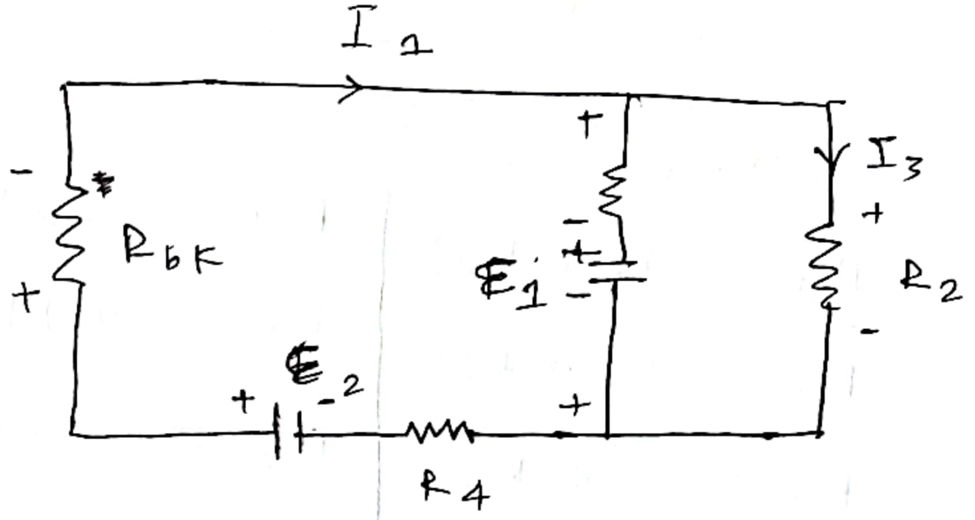
$= 3.49186\,k\Omega$

$= 3491.86\,\Omega$ (Ans)

b) Current through R_1 is Zero as there is an alternative route.

$R_1 = 0\,A$ (Ans)

c)



$$-R_{bK} I_1 - R_3 I_2 - E_1 - R_4 I_1 + E_2 = 0$$

$$\Rightarrow -3491.86\, I_1 - 33000 I_2 - 8 - 2200 I_1 + 2 = 0$$

$$\Rightarrow 5691.86\, I_1 + 33000 I_2 = -6 \quad \ldots\ (i)$$

$$E_1 + I_2 R_3 - I_3 R_2 = 0$$

$$\Rightarrow 8 + 33000 I_2 - 2200 I_3 = 0$$

$$\Rightarrow 33000 I_2 - 2200 I_3 = -8 \quad \ldots\ (ii)$$

$$I_1 - I_2 - I_3 = 0 \quad \ldots\ (iii)$$

(i), (ii), (iii) solve,

$$I_1 = 1.9344 \times 10^{-4}$$

$$I_2 = -2.1518 \times 10^{-4}$$

$$I_3 = 4.086 \times 10^{-4}$$

value of I_{bk},

$I_1 = 1.9344 \times 10^{-4}$ A (Ans)

d) Here,

$I_3 = 4.086 \times 10^{-4}$ A

$R_2 = 2200\ \Omega$

R_2 resistor power,

$P = (I_3)^2 R_2$

$= (4.086 \times 10^{-4}) \times 2200$

$= 3.6729 \times 10^{-4}$ j/s (Ans)

e) Potential Difference,

$= E_1 + (I_2 \times R_3)$

$= 8 + (-2.1518 \times 10^{-4} \times 33000)$

$= 0.89906$ volts. (Ans)

Ans. To the Q. No. (GA4.2)

a) Here,

$R = 5.2 \text{ cm} = 5.2 \times 10^{-2} \text{ m}$

$R/2 = 0.026 \text{ m}$

$i_1 = -8.5 \text{ A}$, $\mu_0 = 12.566 \times 10^{-7} \text{ H/m}$

Now,

$R_n = R + \frac{R}{2} = (5.2 \times 10^{-2} + 0.026) \text{ m}$

$= 0.078 \text{ m}$

At point c, the magnitude of magnetic field

$$|\vec{B}| = \frac{\mu_0 |i_1|}{2\pi R_n}$$

$$= \frac{12.566 \times 10^{-7} (8.5)}{2\pi \times 0.078}$$

b) At center c due to motion of the electron there will be zero (0) magnitude of magnetic field.

$\therefore$ magnitude $= 0 \ N m^2/C$

(Ans)

c) Magnetic Field,

$$\vec{B} = \frac{\mu_0 i_1 x}{2\pi d}\hat{k}$$

$$= \frac{4\pi \times 10^{-7} \times (8-5)}{2\pi \times 6.1 \times 10^{-2}}\hat{k}$$

$$= 2.786 \times 10^{-5}\hat{k}$$

Here,

$q = e = -1.6022 \times 10^{-19} C$

$d = 6.1 \times 10^{-2} m$

$i_1 = -8.5 A$

$\mu_0 = 4\pi \times 10^{-7} H/m$

$\vec{V}_q = 450 \hat{j} m/s$

Magnetic force, $\vec{F}_B = q(\vec{V}_q \times \vec{B})$

$$\vec{V}_q \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 450 & 0 \\ 0 & 0 & 2.786 \times 10^{-5} \end{vmatrix}$$

$$= \hat{i}(450 \times 2.786 \times 10^{-5}) - \hat{j}(0) - (0)\hat{k}$$

$$= 0.012 \hat{i}$$

$\therefore x$ component $= -1.6022\times10^{-19}\times0.012$

$= -1.922\times10^{-21}$ N (Ans)

$\therefore y$ component $= -1.6022\times10^{-19}\times0$

$= 0$ N (Ans)

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

d) We know,

$$B = \frac{\mu_0 I}{2R}$$

$$\Rightarrow I = \frac{2BR}{\mu_0}$$

$$= \frac{2\times2.179\times10^{-5}\times5.2\times10^{-2}}{4\pi\times10^{-7}}$$

Here,

$B = 2.179\times10^{-5}$ N/C

$R = 5.2\times10^{-2}$ m

$\mu_0 = 4\pi\times10^{-7}$ H/m

$\therefore I = 1.803$ A (Ans)

Ans. To The Q. No. (GA4.3)

a) $\vec{B} = (45 \times 10^9)\hat{j} + (-24 \times 10^9)$ Tesla

$\vec{\tau} = -2924.8985 \times 10^{29} \hat{i}$ N m

$U = 2460.647 \times 10^{29}$ J

$\vec{\mu} = \mu_y \hat{j} + \mu_z \hat{k}$

We know,

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

$$\Rightarrow -2924.8985 \times 10^{29} \hat{i} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & \mu_y & \mu_z \\ 0 & 45 \times 10^9 & -24 \times 10^9 \end{vmatrix}$$

$$\Rightarrow -24 \times 10^9 \mu_y - 45 \times 10^9 \mu_z = -2924.8985 \times 10^{29}$$

$$\Rightarrow 24 \times 10^9 \mu_y + 45 \times 10^9 \mu_z = 2924.8985 \times 10^{29} \quad \ldots (i)$$

Again,

$$U = -\vec{\mu} \cdot \vec{B}$$

$$\Rightarrow 2460.647 \times 10^{29} = \{-(45 \times 10^9 \mu_y) \times (-24 \times 10^9 \mu_z)\}$$

$$\Rightarrow -45 \times 10^9 \mu_y + 24 \times 10^9 \mu_z = 2460.647 \times 10^{29} \quad \ldots (ii)$$

Solving (i) & (ii)

$$\mu_y = -1.5583 \times 10^{21} \ Nm/T$$

$$\mu_z = 7.331 \times 10^{21} \ Nm/T$$

b) $U = -\vec{\mu} \cdot \vec{B}$

$$= -|\vec{\mu}| \, |\vec{B}| \cos\theta$$

$$\Rightarrow 2460.647 \times 10^{29} = \sqrt{(-1.5583\times10^{21})^2 + (7.331\times10^{21})^2}$$

$$\sqrt{(45\times10^9)^2 + (-24\times10^9)^2} \cos\theta$$

$$\cancel{\Rightarrow \theta = \cos^{-1}\left(\frac{2460.647\times10^{29}}{7.4948\times10^{21} \times 2.08\times10^{20}}\right)}$$

$$\cancel{\Rightarrow \theta = \cos^{-1}\left(\frac{2460.647\times10^{29}}{7.4948\times10^{21} \times 5.1\times10^{10}}\right)}$$

$$\Rightarrow \theta = \cos^{-1}\left(\frac{+2460.6474\times10^{29}}{7.4948\times10^{21} \times 5.1\times10^{10}}\right)$$

$$\therefore \theta = 130.0723 \text{ degrees}$$

(Ans)

c) Here,

$$U_{min} = -\vec{\mu} \cdot \vec{B} \quad [\because \theta = 0^\circ]$$

$$\therefore U_{min} = -|\vec{\mu}|\,|\vec{B}| \cos(\theta)$$

$$= -7.4948 \times 10^{22} \times 5.1 \times 10^{10} \times \cos(0)$$

$$= -3.822348 \times 10^{32} \text{ N m}$$

(Ans)

d) Let,

$$\vec{\mu'} = \vec{\mu'_y}\,\hat{j} + \vec{\mu'_z}\,\hat{k}$$

So,

$$-\vec{\mu'} \cdot \vec{B} = U_{min}$$

$$\Rightarrow \cdot 45 \times 10^9 \mu'_y \cdot \hat{j} - 24 \times 10^9 \mu'_z \hat{k} = 3.822348 \times 10^{32} \quad \ldots (i)$$

Now,

$$U_{min}, \vec{\tau} = \vec{0}$$

$$\vec{\mu}' \times \vec{B} = 0$$

~~$\Rightarrow 45 \times 10^9 \mu_y \hat{j} - 2$~~

$$\Rightarrow \cdot 24 \times 10^9 \mu'_y \hat{j} + 45 \times 10^9 \mu'_z \hat{k} = 0 \quad \ldots (ii)$$

Solving (i) & (ii)

$$\mu'_y = 6.613 \times 10^{21} \; Nm/T$$

$$\mu'_z = -3.5269 \times 10^{21} \; Nm/T$$

e) $\Delta U = U - U_{min}$

$$= 2460.6474254 \times 10^{29}$$

$$- (-3.822348 \times 10^{23})$$

$$= 6.2829 \times 10^{32} \text{ joules}$$

(Ans)

f) From (a),

$$\vec{\mu} = -1.5583 \times 10^{21} \hat{j} + 7.331 \times 10^{21} \hat{k}$$

$$|\vec{\mu}| = 7.49479 \times 10^{21} \; Nm/T$$

$$= 7.49479 \times 10^{21} \; Nm/T \quad \text{(Ans)}$$

From (d),

$$\vec{\mu}' = 6.621 \times 10^{21} \hat{j} - 3.5269 \times 10^{21} \hat{k}$$

$$|\vec{\mu}'| = \sqrt{(6.621 \times 10^{21})^2 + (-3.5269 \times 10^{21})^2}$$

$$= 7.5018 \times 10^{21} \quad \text{(Ans)}$$

Q1 For, $\theta = 180^\circ$ the pontential energy and torque is maximum,

So,

$$U_{max} = -\vec{\mu}\cdot\vec{B}$$

$$= -|\vec{\mu}||\vec{B}|\cos(180^\circ)$$

$$= -7.4948\times10^{21}\times 5.1\times10^{10}\cos(180)$$

$$= 3.822348\times10^{32} \text{ Joules}$$

(Ans)