14. MAGNETIC EFFECT OF ELECTRIC CURRENT

1. A rectangular coil in a moving galvanometer has 50 turns each of length 5 cm and breadth 3 cm, which is suspended in a radial magentic field of 0.050 Wb/m². The twist constant of suspension is 1.5 × 10⁻⁹ Nm/deg. Calculate the current through the coil which will deflect it through 30⁰.

Given :

n = 50

C = 1.5×10^{-9} Nm/deg

B = 0.05 Wb/m²

θ = 30^0

A = $l \times b = 5 \times 3$

= 15 cm²

= 15×10^{-4} m²

To Find :

I = ?

Formula :

$$I = \frac{c\theta}{nAB}$$

Solution :

$$I = \frac{c\theta}{nAB}$$

$$I = \frac{1.5\times10^{-9}\times30}{50\times15\times10^{-4}\times0.05}$$

$\therefore$ I = 1.2×10^{-5} A

2. A galvanometer with a coil of resistance 40 ohm gives a full scale deflection for a current of 5 mA. How will you convert it into an ammeter of range 0–5 A ?

Given :

G = 40 Ω

I_g = 5 mA

= 5×10^{-3} A

I = 5 A

To Find :

S = ?

Formula :

$$S = \left(\frac{I_g}{I - I_g}\right)G$$

Solution :

$$S = \left(\frac{I_g}{I - I_g}\right)G$$

$$S = \left(\frac{5\times10^{-3}}{5 - 5\times10^{-3}}\right) \times 40$$

= 0.04 Ω

$\therefore$ S = 0.04 Ω

$\therefore$ A shunt of 0.04 Ω is to be connected in parallel with galvanometer (convert if in to am meter of range 0 – 5 A).

3. Calculate the value of resistance needed to convert a moving coil galanometer of 60 Ω into an ammeter of range 5 A which gives full scale deflection for a current of 50 mA and into voltmeter of range 0 – 50 V.

Given :

G = 60 Ω

V = 50 V

I = 5 A

I_g = 50 mA = 50×10^{-3} A

= 5×10^{-2} A

To Find :

i) R_s = ?

Formula :

i) $$R_s = \frac{V}{I_g} - G$$

ii) $$S = \frac{GI_g}{I - I_g}$$

Solution :

$$R_s = \frac{V}{I_g} - G$$

$$R_s = \frac{50}{5\times10^{-2}} - 60$$

$\therefore \quad R_s = 1000 - 60$

$\therefore \quad R_s = 940\ \Omega$

$$S = \frac{GI_g}{I - I_g}$$

$$S = \frac{60\times0.05}{5 - 0.05}$$

$$= \frac{3}{4.95}$$

$\therefore \quad S = 0.6061\ \Omega$

$\therefore$ A resistance of 0.6061 Ω in parallel and 940 Ω in series is connected to M.C.G.

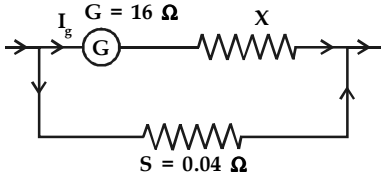
4. A galvanometer has a resistance of 16 Ω and gives a full scale deflection when a current of 20 mA is passed through it. The only shunt resistance available is 0.04 Ω which is not appropriate to convert galvanometer into an ammeter. How much resistance should be connected in series with coil of galvanometer so that the range of ammeter is 10 A ?

Solution :

Let 'X' be the resistance connected in series with galvanometer.

Since S is not sufficient for I = 10 A

G = 16 Ω,



$\therefore$ From the figure,

$$\frac{I_g}{I} = \frac{S}{(G+X)+S}$$

$$\therefore \quad (G + X) + S = \frac{I}{I_g}S$$

$$\therefore \quad (16 + X + 0.04) = \frac{10}{2\times10^{-2}} \times 0.04$$

$\therefore \quad (16 + X + 0.04) = 20$

$\therefore \quad X = 20 - 16.04$

$\therefore \quad X = \mathbf{3.96\ \Omega}$

5. A resistance of 3 ohm is connected in parallel to a galvanometer of resistance 297 ohm. Find the fraction of current passing through galvanometer.

Given :

$S = 3\ \Omega$

$G = 297\ \Omega$

To Find :

$$\frac{I_g}{I} = ?$$

Formula :

$$I_gG = (I - I_g)S$$

Solution :

$$I_gG = (I - I_g)S$$

$$\therefore \quad \frac{G}{S} + 1 = \frac{I}{I_g}$$

$$\therefore \quad \frac{G+S}{S} = \frac{I}{I_g}$$

$$\therefore \quad \frac{I_g}{I} = \frac{S}{G+S} = \frac{3}{297+3}$$

$$\therefore \quad \frac{I_g}{I} = \frac{3}{300} = \left[\frac{3}{300}\times100\right]$$

$$\therefore \quad \frac{I_g}{I} = 0.01 \text{ or } 1\ \%$$

6. The combined resistance of galvanometer of resistance 1000 ohm and its shunt is 25 ohm. Calculate the value of shunt.

Given :

$G = 1000\ \Omega$

$R_{eq} = 25\ \Omega$

To Find :

$S = ?$

Formula :

$$\frac{1}{R_{eq}} = \frac{1}{G} + \frac{1}{S}$$

Solution :

$$\frac{1}{R_{eq}} = \frac{1}{G} + \frac{1}{S}$$

$$\frac{1}{S} = \frac{1}{R_{eq}} - \frac{1}{G} = \frac{G - R_{eq}}{R_{eq}\,G}$$

$$\therefore\ S = \frac{R_{eq}\,G}{G - R_{eq}}$$

$$\therefore\ S = \frac{25 \times 1000}{1000 - 25}$$

$$= \frac{25 \times 1000}{975}$$

$$\therefore\ S = 25.64\ \Omega$$

7. A rectangular coil of moving coil galvanometer contains 50 turns each having area 12 cm². It is suspended in radial magentic field of induction 0.025 Wb/m² by a fibre of twist constant 15×10^{-10} Nm/deg. Calculate the sensitvity of a moving coil galvanometer.

Given :

$n = 50$

$A = 12\ cm^2$

$= 12 \times 10^{-4}\ m^2$

$B = 0.025\ Wb/m^2$

$c = 15 \times 10^{-10}\ Nm/deg$

To Find :

$S_i = ?$

Formula :

$$S_i = \frac{nAB}{c}$$

Solution :

Current sensitivity of MCG

$$S_i = \frac{nAB}{c}$$

$$S_i = \frac{50 \times 12 \times 10^{-4} \times 0.025}{15 \times 10^{-10}}$$

$$\therefore\ S_i = 10^6\ deg/A$$