



Student's name and surname	Mock Exam 1	اسم و لقب الطالب:
.....	Electricity	الرقم الجامعي:
Date:10- 05- 2025 Time: 45 minutes	second semester 1446 H 2024/2025	ملاحظة :

1 Exercise :1 5pts

What is the equivalent resistance of these resistances in this circuit figure 1 1 ? If a potential difference of 60 V is applied across the terminals of the assembly, what is the current flowing through each resistance?

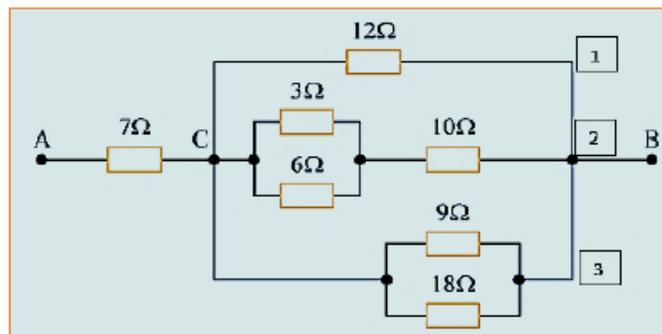


Figure 1: circuit 1

2 Exercise :2 5pts

Given the following circuit 2 parameters:

$$E = 10 \text{ V};$$

$$E_2 = 3 \text{ V};$$

$$R_1 = 1 \text{ k}\Omega;$$

$$R_3 = 3.3 \text{ k}\Omega$$

$$E_1 = 5 \text{ V};$$

$$E_3 = 6 \text{ V};$$

$$R_2 = 2.2 \text{ k}\Omega;$$

Calculate the current I supplied by the voltage source E .

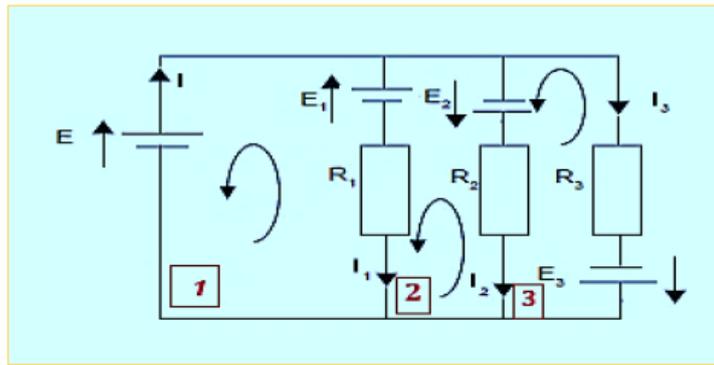


Figure 2: circuit 2

3 Exercise 3 5pts

A flat coil consisting of one turn with a radius of 10 centimeters carries a current of intensity I .

1. How should this coil be oriented if we want the total magnetic field at the center of the coil to be zero (taking into account the Earth's magnetic field, which is $B_{\text{earth}} = 2.2 \times 10^{-5}$ tesla)?
2. What should be the current intensity I in this case?
3. Same question for a coil with 50 turns?

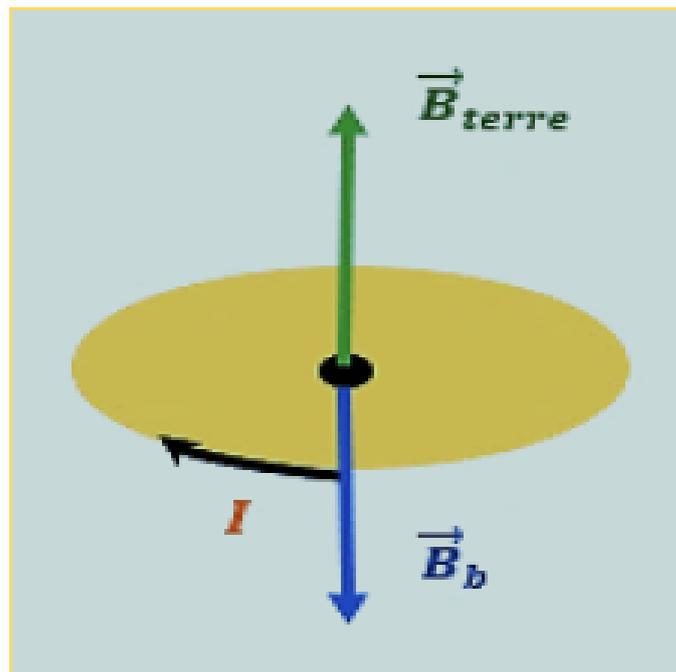


Figure 3: magnetic field

Solution to the Circuit Problem

4 Solution Exo1

Step 1: Simplify the Circuit

Refer to the labeled nodes in the figure.

- The 6 and 3 resistors are in parallel:

$$R_1 = \left(\frac{1}{6} + \frac{1}{3} \right)^{-1} = \left(\frac{1}{6} + \frac{2}{6} \right)^{-1} = \left(\frac{3}{6} \right)^{-1} = 2 \Omega$$

Award: 1 pts

- The result (2) is in series with the 12 resistor:

$$R_2 = 2 + 12 = 14 \Omega$$

- The 9 and 18 resistors are in parallel:

$$R_3 = \left(\frac{1}{9} + \frac{1}{18} \right)^{-1} = \left(\frac{2+1}{18} \right)^{-1} = \left(\frac{3}{18} \right)^{-1} = 6 \Omega$$

Award: 1 pts

- Now, $R_2 = 14 \Omega$, $R_3 = 6 \Omega$, and the 10 resistor are all in parallel:

$$\begin{aligned} R_{ABC} &= \left(\frac{1}{14} + \frac{1}{10} + \frac{1}{6} \right)^{-1} \\ &= \left(\frac{15 + 21 + 35}{210} \right)^{-1} = \left(\frac{71}{210} \right)^{-1} \approx 2.96 \Omega \end{aligned}$$

- Finally, this is in series with the 7 resistor:

$$R_{eq} = 7 + 2.96 = 9.96 \Omega$$

Award: 1 pts

Step 2: Total Current from Source

$$I_{\text{total}} = \frac{V}{R_{\text{eq}}} = \frac{60}{9.96} \approx 6.02 \text{ A}$$

Step 3: Voltage at Node C

$$V_C = I_{\text{total}} \times 7 = 6.02 \times 7 = 42.14 \text{ V}$$

$$V_{\text{CB}} = 60 - 42.14 = 17.86 \text{ V}$$

Award: 1 pts

Step 4: Current Distribution

Branch with 10 resistor:

$$I_{10} = \frac{17.86}{10} = 1.786 \text{ A}$$

Branch with 14 (from 3/6 and 12):

$$I_{14} = \frac{17.86}{14} = 1.276 \text{ A}$$

Branch with 6 (from 9/18):

$$I_6 = \frac{17.86}{6} = 2.976 \text{ A}$$

Current split in the 3 and 6 parallel:

$$V = I_{14} \times 2 = 1.276 \times 2 = 2.552 \text{ V}$$

$$I_3 = \frac{2.552}{3} \approx 0.851$$

- Q1 (Orientation): 1.5 pts
- Q2 (1 turn): 1.5 pts
- Q3 (50 turns): 1 pts
- Q4 (50 turns): 1 pts

5 Solution to Circuit 2

5.1 Given

- $E = 10 \text{ V}$, $E_1 = 5 \text{ V}$, $E_2 = 3 \text{ V}$, $E_3 = 6 \text{ V}$
- $R_1 = 1 \text{ k}\Omega$, $R_2 = 2.2 \text{ k}\Omega$, $R_3 = 3.3 \text{ k}\Omega$

Let the mesh currents be:

$$I_1, \quad I_2, \quad I_3$$

Step 1: Mesh Equations

Mesh 1:

$$\begin{aligned}E - I_1 R_1 - E_1 - R_2(I_1 - I_2) &= 0 \\10 - 1000I_1 - 5 - 2200(I_1 - I_2) &= 0 \\5 - 1000I_1 - 2200I_1 + 2200I_2 &= 0 \\(-3200)I_1 + 2200I_2 &= -5\end{aligned}\tag{1}$$

Mesh 2:

$$\begin{aligned}-E_2 - R_2(I_2 - I_1) - R_3(I_2 - I_3) &= 0 \\-3 - 2200(I_2 - I_1) - 3300(I_2 - I_3) &= 0 \\-3 - 2200I_2 + 2200I_1 - 3300I_2 + 3300I_3 &= 0 \\2200I_1 - 5500I_2 + 3300I_3 &= 3\end{aligned}\tag{2}$$

Mesh 3:

$$\begin{aligned}-R_3(I_3 - I_2) - E_3 &= 0 \\-3300(I_3 - I_2) - 6 &= 0 \\-3300I_3 + 3300I_2 = 6 &\Rightarrow 3300I_2 - 3300I_3 = 6\end{aligned}\tag{3}$$

Award: 2 pts

Step 2: Solve the System of Equations

From equation (3):

$$3300I_2 - 3300I_3 = 6 \Rightarrow I_2 - I_3 = \frac{6}{3300} = \frac{1}{550} \Rightarrow I_3 = I_2 - \frac{1}{550}$$

Substitute into (2):

$$\begin{aligned}2200I_1 - 5500I_2 + 3300\left(I_2 - \frac{1}{550}\right) &= 3 \\2200I_1 - 5500I_2 + 3300I_2 - 6 &= 3 \\2200I_1 - 2200I_2 = 9 &\Rightarrow I_1 - I_2 = \frac{9}{2200} \Rightarrow I_1 = I_2 + \frac{9}{2200}\end{aligned}$$

Substitute I_1 into (1):

$$\begin{aligned}-3200\left(I_2 + \frac{9}{2200}\right) + 2200I_2 &= -5 \\-3200I_2 - \frac{28800}{2200} + 2200I_2 &= -5 \Rightarrow -1000I_2 - 13.09 \approx -5 \\-1000I_2 = 8.09 &\Rightarrow I_2 \approx -8.09 \times 10^{-3} = -8.09 \text{ mA}\end{aligned}$$

Then:

$$I_1 = I_2 + \frac{9}{2200} \approx -8.09 \text{ mA} + 4.09 \text{ mA} = -4.00 \text{ mA}$$

Award: 2 pts

Step 3: Final Answer

The current supplied by the source E is $I = |I_1| = 4 \text{ mA}$

Award: 1 pts

Total: 5 Points

- Q1 (Orientation): 2 pts
- Q2 (1 turn): 2 pts
- Q3 (50 turns): 1 pts

6 Exercise 3 – Magnetic Field of a Coil

7 Problem Statement

A flat coil consisting of one turn with a radius of $R = 10 = 0.1$ carries a current of intensity I . The Earth's magnetic field is given as:

$$B_{\text{Earth}} = 2.2 \times 10^{-5} \text{ T}$$

1. Orientation for Zero Magnetic Field at the Center

(1.5 points)

To cancel the Earth's magnetic field at the center of the coil, the magnetic field generated by the coil, \vec{B}_b , must be equal in magnitude but opposite in direction to \vec{B}_{Earth} .

Conclusion: The coil must be oriented such that its axis (normal vector) is aligned with the Earth's magnetic field, and the current flows in the direction that produces a magnetic field pointing **downward** to oppose \vec{B}_{Earth} (which points upward).

Award: 1.5 pts

2. Current Intensity for One Turn

(2 points)

The magnetic field at the center of a circular loop of radius R carrying current I is given by:

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

To cancel B_{Earth} , we set $B = B_{\text{Earth}}$:

$$\frac{\mu_0 I}{2R} = B_{\text{Earth}} \Rightarrow I = \frac{2RB_{\text{Earth}}}{\mu_0}$$

Substitute:

$$\mu_0 = 4\pi \times 10^{-7} \text{ H/m}, \quad R = 0.1 \text{ m}, \quad B_{\text{Earth}} = 2.2 \times 10^{-5} \text{ T}$$

$$I = \frac{2 \times 0.1 \times 2.2 \times 10^{-5}}{4\pi \times 10^{-7}} = \frac{4.4 \times 10^{-6}}{4\pi \times 10^{-7}} = \frac{4.4}{4\pi} \times 10 \approx \frac{4.4 \times 10}{12.566} \approx 3.5 \text{ A}$$

Answer: $I \approx 3.5 \text{ A}$

Award: 2 pts

3. Current for a Coil with 50 Turns

(1.5 points)

For N turns, the magnetic field becomes:

$$B = \frac{\mu_0 NI}{2R} \Rightarrow I = \frac{2RB_{\text{Earth}}}{\mu_0 N}$$

$$I = \frac{2 \times 0.1 \times 2.2 \times 10^{-5}}{4\pi \times 10^{-7} \times 50} = \frac{4.4 \times 10^{-6}}{200\pi \times 10^{-7}} = \frac{4.4}{200\pi} \times 10 \approx \frac{4.4 \times 10}{628.3} \approx 0.07 \text{ A}$$

Answer: $I \approx 70 \text{ mA}$

Award: 1.5 pts

Total: 5 Points

- Q1 (Orientation): 1.5 pts
- Q2 (1 turn): 2 pts
- Q3 (50 turns): 1.5 pts