جامعة الفرات الاوسط التقنية / المعهد التقني- سماوة
قسم التقنيات الكهربائية

المحاضرة الخامسة

اسم المادة / دوائر كهربائية

المرحلة الدراسية / الاولى

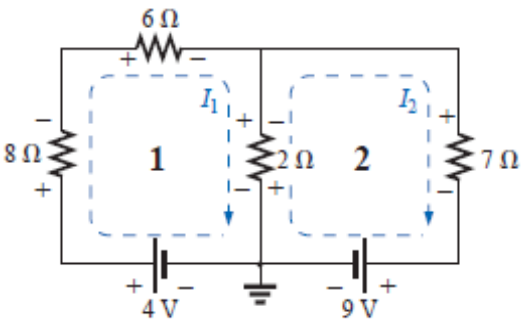
العام الدراسي / 2022 – 2023

استاذ المادة : بشائر مكي جبر

Chapter 2
Series and parallel resistance

The mesh-analysis approach simply eliminates the need to substitute the results of Kirchhoff's current law into the equations derived from Kirchhoff's voltage law. It is now accomplished in the initial writing of the equations.

EXAMPLE 2.10 Write the mesh equations for the network of Fig. below, and find the current through the 7-Ω resistor ??



Solution

$$I_1: \quad (8\ \Omega + 6\ \Omega + 2\ \Omega)I_1 - (2\ \Omega)I_2 = 4\ \text{V}$$
$$I_2: \quad (7\ \Omega + 2\ \Omega)I_2 - (2\ \Omega)I_1 = -9\ \text{V}$$

and

$$16I_1 - 2I_2 = 4$$
$$9I_2 - 2I_1 = -9$$

which, for determinants, are

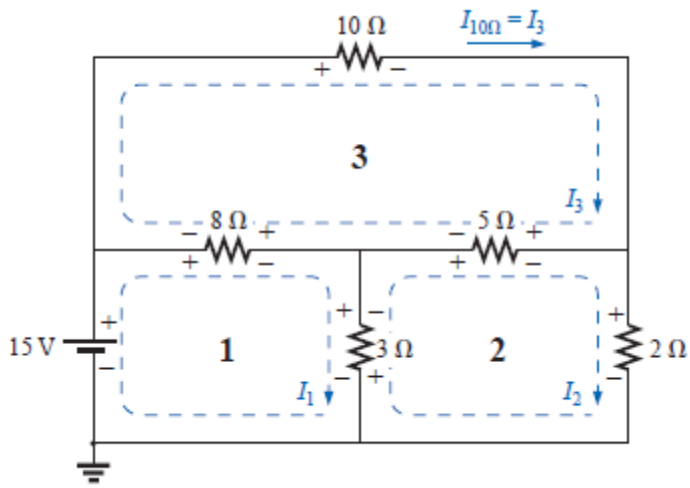
$$16I_1 - 2I_2 = 4$$
$$-2I_1 + 9I_2 = -9$$

and

$$I_2 = I_{7\Omega} = \frac{\begin{vmatrix} 16 & 4 \\ -2 & -9 \end{vmatrix}}{\begin{vmatrix} 16 & -2 \\ -2 & 9 \end{vmatrix}} = \frac{-144 + 8}{144 - 4} = \frac{-136}{140}$$
$$= \mathbf{-0.971\ A}$$

Chapter 2
Series and parallel resistance

EXAMPLE 2.11 Find the current through the 10-Ω resistor of the network of Fig. below .



Solution:

$$
\begin{array}{ll}
I_1: & (8\ \Omega + 3\ \Omega)I_1 - (8\ \Omega)I_3 - (3\ \Omega)I_2 = 15\ \text{V} \\
I_2: & (3\ \Omega + 5\ \Omega + 2\ \Omega)I_2 - (3\ \Omega)I_1 - (5\ \Omega)I_3 = 0 \\
I_3: & (8\ \Omega + 10\ \Omega + 5\ \Omega)I_3 - (8\ \Omega)I_1 - (5\ \Omega)I_2 = 0
\end{array}
$$

$$
\begin{aligned}
11I_1 - 8I_3 - 3I_2 &= 15 \\
10I_2 - 3I_1 - 5I_3 &= 0 \\
23I_3 - 8I_1 - 5I_2 &= 0
\end{aligned}
$$

or

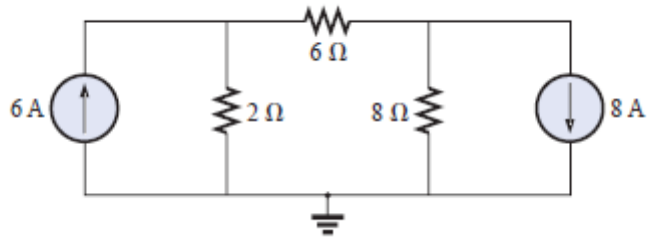
$$
\begin{aligned}
11I_1 - 3I_2 - 8I_3 &= 15 \\
-3I_1 + 10I_2 - 5I_3 &= 0 \\
-8I_1 - 5I_2 + 23I_3 &= 0
\end{aligned}
$$

and

$$
I_3 = I_{10\Omega} = \frac{\begin{vmatrix} 11 & -3 & 15 \\ -3 & 10 & 0 \\ -8 & -5 & 0 \end{vmatrix}}{\begin{vmatrix} 11 & -3 & -8 \\ -3 & 10 & -5 \\ -8 & -5 & 23 \end{vmatrix}} = \mathbf{1.220\ A}
$$

EXAMPLE 2.12 Using mesh analysis, determine the currents for the network of Fig. below .

Chapter 2
Series and parallel resistance



Solution:

$$I_1 = 6\text{ A}$$
$$I_3 = 8\text{ A}$$

results in the following solutions:

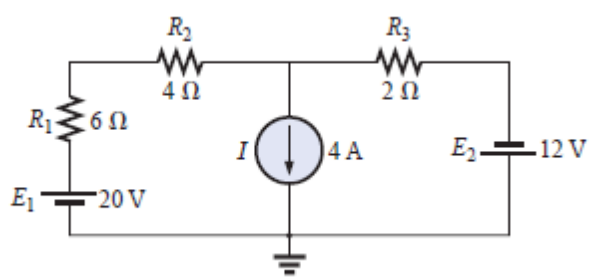
$$2I_1 - 16I_2 + 8I_3 = 0$$
$$2(6\text{ A}) - 16I_2 + 8(8\text{ A}) = 0$$

and $$I_2 = \frac{76\text{ A}}{16} = \mathbf{4.75\ A}$$

Then $$I_{2\Omega}\downarrow = I_1 - I_2 = 6\text{ A} - 4.75\text{ A} = \mathbf{1.25\ A}$$

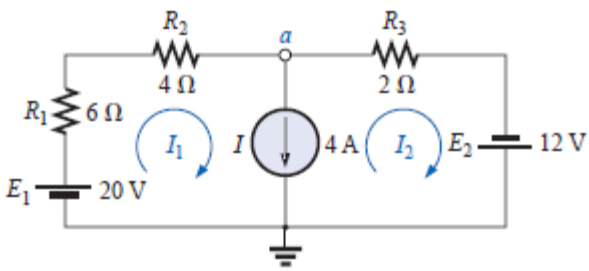
and $$I_{8\Omega}\uparrow = I_3 - I_2 = 8\text{ A} - 4.75\text{ A} = \mathbf{3.25\ A}$$

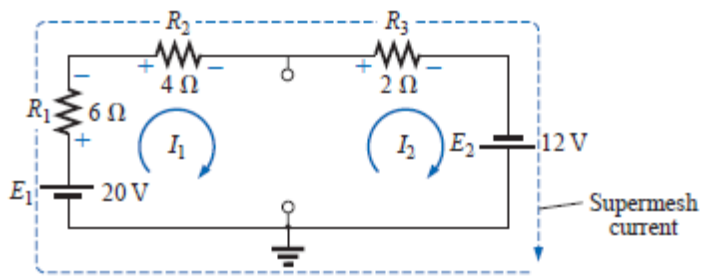
EXAMPLE 2.13 Using mesh analysis, determine the currents of the network of Fig. below.



Solution:

Chapter 2
Series and parallel resistance





Applying Kirchhoff's law:

$$20\text{ V} - I_1(6\ \Omega) - I_1(4\ \Omega) - I_2(2\ \Omega) + 12\text{ V} = 0$$

or

$$10I_1 + 2I_2 = 32$$

Node a is then used to relate the mesh currents and the current source using Kirchhoff's current law:

$$I_1 = I + I_2$$

The result is two equations and two unknowns:

$$\begin{aligned} 10I_1 + 2I_2 &= 32 \\ I_1 - I_2 &= 4 \end{aligned}$$

Applying determinants:

$$I_1 = \frac{\begin{vmatrix} 32 & 2 \\ 4 & -1 \end{vmatrix}}{\begin{vmatrix} 10 & 2 \\ 1 & -1 \end{vmatrix}} = \frac{(32)(-1) - (2)(4)}{(10)(-1) - (2)(1)} = \frac{40}{12} = \mathbf{3.33\ A}$$

and

$$I_2 = I_1 - I = 3.33\text{ A} - 4\text{ A} = \mathbf{-0.67\ A}$$

Maxwell's loop current method

This method is derived from (KVL) and can be applied by the following step:

1. Convert all current sources in the circuit to voltage sources.
2. Assign independent loop in the circuit to be analyzed (all the loop have the same direction).
3. Write the loop equations of the circuit as in the following formulas.

$$I_1\sum R_{loop1} - I_2\sum R_{between\ loop1\&2} - \ldots\ldots\ldots\ldots - I_n\sum R_{between\ loop1\&n} = \sum V_{loop1} \ldots\ldots (1)$$

$$-I_1\sum R_{between\ loop1\&2} + I_2\sum R_{loop2} - \ldots\ldots\ldots\ldots - I_n\sum R_{between\ loop2\&n} = \sum V_{loop2} \ldots (2)$$

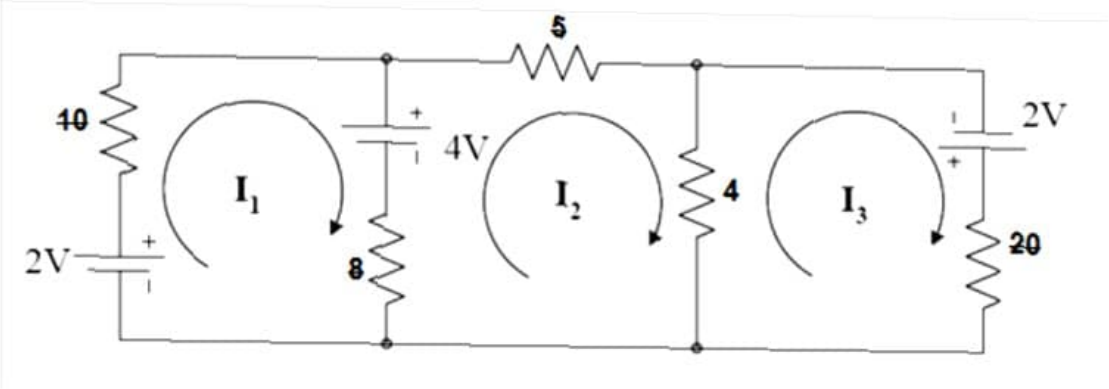
. . . .

. . . .

$$-I_1\sum R_{between\ loop1\&n} - I_2\sum R_{between\ loopn\&2} - \ldots\ldots\ldots + I_n\sum R_{loopn} = \sum V_{loopn} \ldots\ldots (n)$$

4. Solve the above equation to find out the current value($I_1, I_2 \ldots\ldots I_n$)

Example-15: write the mesh equation for the network shown below.(all resistors value are in ohm)



$I_1(10+8) - I_2(8) - I_3*0 = 2-4$……1

$-I_1(8) + I_2(8+5+4) - I_3(4) = 4$……....2

$I_1*(0) - I_2(4) + I_3(4+20) = 2$……3

Rewrite the above equation:

$18 I_1 - 8I_2 = -2$……1

$-8I_1+17I_2 - 4I_3 = 4$……....2

$- 4I_2 + 24I_3 = 2$……3

Solve the above equation we obtain:

$$I_1 = - 0.54A , I_2 = 0.92 A , I_3 = 0.678 A$$

Example-16: Find the current through the 10Ω resistor.

Solution:

Loop1 $(8+3)I_1-(3)I_2-(8)I_3=15$

Loop2 $-(3)I_1+(3+5+2)I_2-(5)I_3=0$

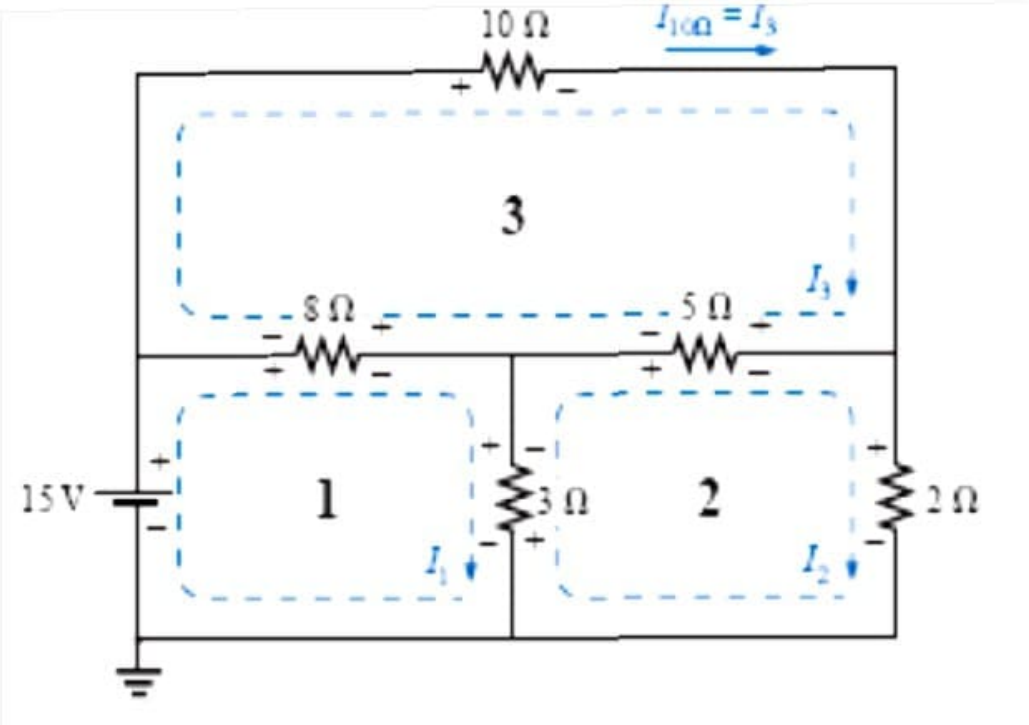
Loop3 $-(8)I_3-(5)I_2+(8+5+10)I_3=0$

Rewrite the above equation

$11I_1-3I_2-8I_3=15$

$-3I_1+10I_2-5I_3=0$

$-8I_3 - 5I_2 + 2I_3 = 0$



The current through 10 ohm resistor is I3 and can be determined using the determinates:

$$I_3 = I_{10\Omega} = \frac{\begin{vmatrix} 11 & -3 & 15 \\ -3 & 10 & 0 \\ -8 & -5 & 0 \end{vmatrix}}{\begin{vmatrix} 11 & -3 & -8 \\ -3 & 10 & -5 \\ -8 & -5 & 23 \end{vmatrix}} :$$

$I_3 = 1.220A$