



UNIVERSITY OF HILLA
College of Engineering Technologies
Department of Medical Devices Technologies

Fundamental of Electrical Engineering(DC)
Mesh Analysis
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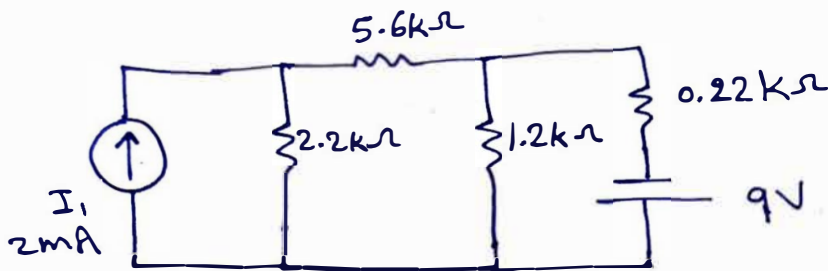
First Stage

Lecture 5

Mesh Analysis (Loop method)

In this method, we use Kirchhoff's laws :-

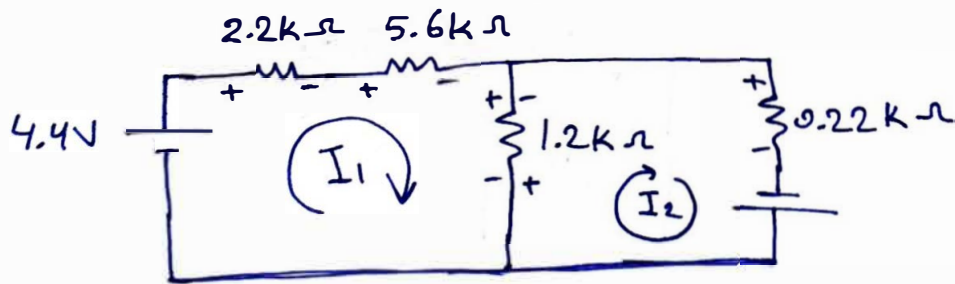
Ex:- using Mesh analysis and Source transform find the current flow through the voltage source (9V).



Sol/

in mesh analysis, we try to reduce the number of loops to easy the solution, so we convert the current source to voltage source

$$V_2 = I_1 R_1 = 2 \times 10^{-3} \times 2.2 \times 10^3 = 4.4 \text{ Volt}$$



$$\text{loop 1:- } 4.4 - 2.2k I_1 - 5.6k I_1 - 1.2k (I_1 - I_2) = 0$$

$$4.4 - 2.2k I_1 - 5.6k I_1 - 1.2k I_1 + 1.2k I_2 = 0$$

$$4.4 - 9k I_1 + 1.2k I_2 = 0$$

$$9k I_1 - 1.2k I_2 = 4.4 \dots\dots \textcircled{1}$$

loop 2:-

$$-1.2K(I_2 - I_1) - 0.22KI_2 + 9 = 0$$

$$-1.2KI_2 + 1.2KI_1 - 0.22KI_2 + 9 = 0$$

$$1.2KI_1 - 1.42KI_2 + 9 = 0 \Rightarrow -1.2KI_1 + 1.42KI_2 = 9 \dots (2)$$

$$9KI_1 - 1.2KI_2 = 4.4 \dots (1)$$

$$(-1.2KI_1 + 1.42KI_2 = 9 \dots (2)) \times 7.5$$

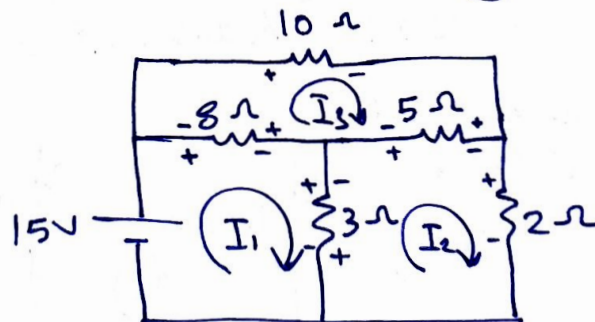
$$9KI_1 - 1.2KI_2 = 4.4$$

$$-9KI_1 + 10.65KI_2 = 67.5$$

$$9.45KI_2 = 71.9$$

$$\boxed{I_2 = \frac{71.9}{9.45K} = 7.608 \text{ mA}}$$

Ex:- From the circuit in figure below, find the current flow through the resistance (10Ω) using Mesh analysis.



Sol/ Loop 1:- $15 - 8(I_1 - I_3) - 3(I_1 - I_2) = 0$

$$15 - 8I_1 + 8I_3 - 3I_1 + 3I_2 = 0$$

$$15 - 11I_1 + 3I_2 + 8I_3 = 0$$

$$11I_1 - 3I_2 - 8I_3 = 15 \dots (1)$$

loop 2:-

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

$$-3I_2 + 3I_1 - 5I_2 + 5I_3 - 2I_2 = 0$$

$$3I_1 - 10I_2 + 5I_3 = 0 \dots \textcircled{2}$$

loop 3:-

$$-8(I_3 - I_1) - 10I_3 - 5(I_3 - I_2) = 0$$

$$-8I_3 + 8I_1 - 10I_3 - 5I_3 + 5I_2 = 0$$

$$8I_1 + 5I_2 - 23I_3 = 0 \dots \textcircled{3}$$

في حالة 3 متغيرات، توجد طريقة المصفوفة بالأضامة الى طريقة الكزن
لكن تكون مطوية

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

$$\Delta_{\text{المصفوفة الكزن}} = \begin{bmatrix} 11 & -3 & -8 \\ 3 & -10 & 5 \\ 8 & 5 & -23 \end{bmatrix} = 11(-10 \times -23 - 5 \times 5) - 3(-10 \times -23 - 5 \times 8) - 8(3 \times 5 - (-10 \times 8))$$

$$= 11(230 - 25) + 3(-69 - 40) - 8(15 + 80)$$

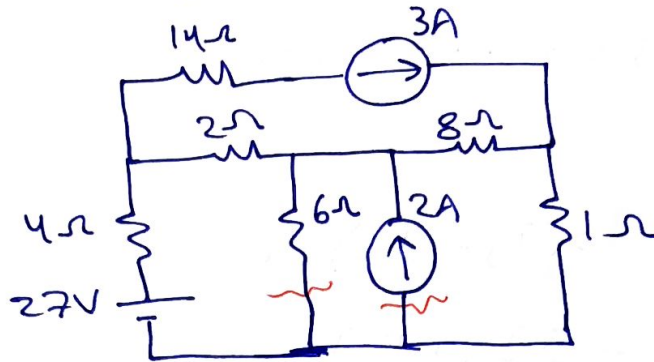
$$= 11(205) + 3(-109) - 8(95) = 2255 - 327 - 760 = 1168$$

$$\Delta = 11(205) + 3(-109) - 8(95) = 2255 - 327 - 760 = 1168$$

$$\Delta_3 = \begin{bmatrix} 11 & -3 & 15 \\ 3 & -10 & 0 \\ 8 & 5 & 0 \end{bmatrix} = 11(-10 \times 0 - 0 \times 5) + 3(3 \times 0 - 0 \times 8) + 15(3 \times 5 - (-10 \times 8))$$

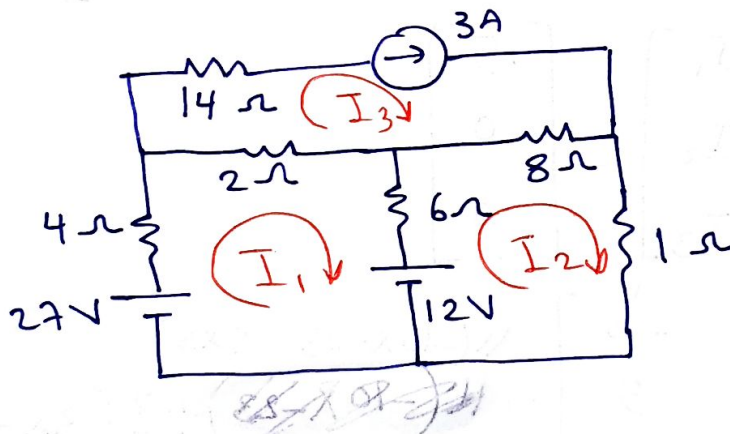
$$I_3 = \frac{\Delta_3}{\Delta} = \frac{1425}{1168} = 1.22 \text{ A}$$

Ex:- Using Mesh analysis, Calculate the Power dissipated through the resistance (8Ω) and the current through the resistance (1Ω).



Sol/ First, we use the Source Conversion by converting the current source into voltage source.

$$V = 6 \times 2 = 12 \text{ Volt}$$



Loop 1:-

$$+27 - 4I_1 - 2(I_1 - I_3) - 6(I_1 - I_2) - 12 = 0$$

$$27 - 4I_1 - 2I_1 + 2I_3 - 6I_1 + 6I_2 - 12 = 0$$

$$15 - 12I_1 + 6I_2 + 2I_3 = 0$$

$$12I_1 - 6I_2 - 2I_3 = 15 \dots\dots (1)$$

Loop 2:-

$$12 - 6(I_2 - I_1) - 8(I_2 - I_3) - 1I_2 = 0$$

$$12 - 6I_2 + 6I_1 - 8I_2 + 8I_3 - 1I_2 = 0$$

$$12 + 6I_1 - 15I_2 + 8I_3 = 0$$

$$-6I_1 + 15I_2 - 8I_3 = 12 \dots\dots (2)$$

loop 3:-

$$I_3 = 3A \dots\dots (3)$$

Sub (3) in (1) and (2)

$$12I_1 - 6I_2 - 2(3) = 15 \Rightarrow 12I_1 - 6I_2 - 6 = 15$$

$$12I_1 - 6I_2 = 15 + 6 \Rightarrow 12I_1 - 6I_2 = 21 \dots\dots (4)$$

$$-6I_1 + 15I_2 - 8(3) = 12 \Rightarrow -6I_1 + 15I_2 - 24 = 12$$

$$-6I_1 + 15I_2 = 12 + 24 \Rightarrow -6I_1 + 15I_2 = 36 \dots\dots (5)$$

$$12I_1 - 6I_2 = 21$$

$$(-6I_1 + 15I_2 = 36) \times 2$$

$$12I_1 - 6I_2 = 21$$

$$-12I_1 + 30I_2 = 72$$

$$24I_2 = 93 \Rightarrow \boxed{I_2 = \frac{93}{24} = 3.875A}$$

$$P_{(8\Omega)} = \frac{I_{(8\Omega)}^2}{R}$$

$$I_{(8\Omega)} = I_2 - I_3 = 3.875 - 3 = 0.875A$$

$$\boxed{P = (0.875)^2 \times 8 = 0.765 \times 8 = 6.125 \text{ watt}}$$

Home Work

Using Mesh analysis find the currents flow through the resistances.

