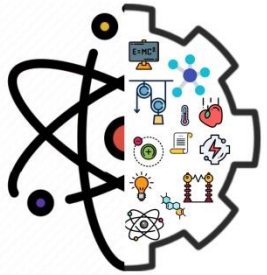

الصفحة الالكترونية لمقررات
الفيزياء لكليات التقنية

المؤسسة العامة للتدريب التقني والمهني
Technical and Vocational Training Corporation

Chapter Six
Kirchhoff's Low

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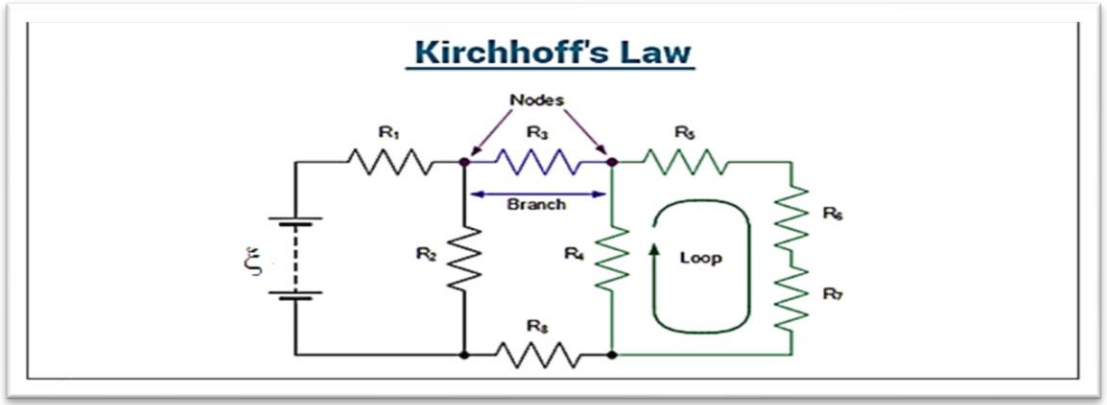
Kirchhoff's laws

That in simple circuits (consisting of straight and parallel connected resistances) current and voltage can be easily found by means of " Ohm " law, but in complex circuits it is not possible, so the scientist Kirchhoff developed a law (Kirchhoff's Laws Circuit) to analyze complex circuits, namely:-

1-the Kirchhoff current law (KCL), also known as the law "conserving Charge".
2-Kirchhoff's law of voltage (KVL), also known as the law of "energy conservation "
The two laws require the definition of the following terms, which are described in the following form:



Important elements:

Node: is a link phrase that connects two or more elements.
Branch: a path that contains one or more elements connecting two nodes.
Loop: a closed loop in which no element or node is repeated more than once.

Noteworthy

Electric current (I)

An electric current is a flow of electric charge in a circuit. and The charge can be negatively charged electrons or positive charge carriers including protons, positive ions.

Electric Voltage (V)

The Voltage it is the pressure that forces the charged electrons to flow in an electrical circuit.

Electrical resistance (R)

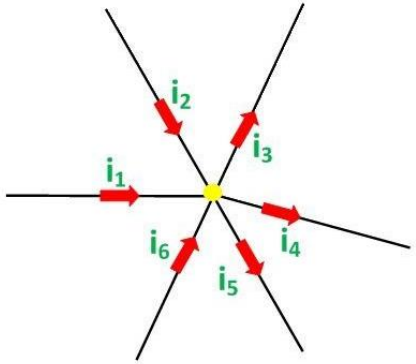
The electrical resistance of an object is a measure of its opposition to the flow of electric current.

The relation between Current and voltage can be given by Ohm's low

$$V = I * R$$

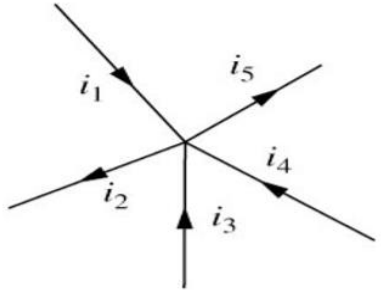
Kirchhoff's Current Law (KCL)

Kirchhoff’s current law (KCL) states that the sum of currents entering a node is zero.



$$\sum_{n=1}^{N} i_n = 0$$

Kirchhoff’s current law (KCL) states that the total currents entering a node is equal the total currents leaving the node.



$$\sum \mathrm{i_{in}} = \sum \mathrm{i_{out}}$$

$$\mathrm{i_1 + i_3 + i_4 = i_5 + i_2}$$

Example 1

From the diagram Find I_3 ?

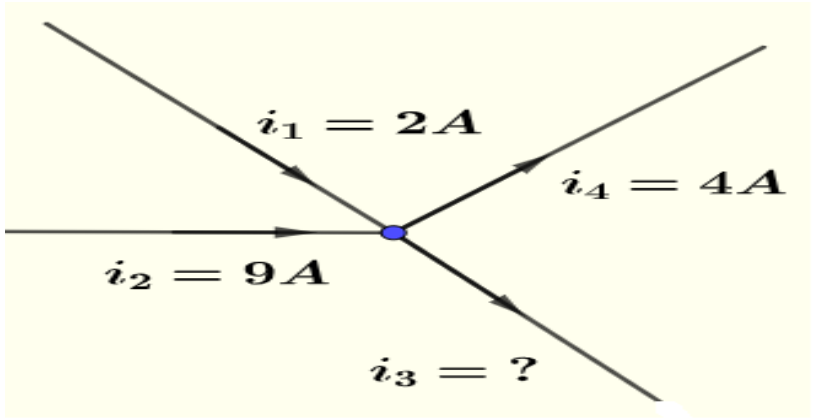
The Solution

$I_1 + I_2 = I_3 + I_4$

Replace each current into its value

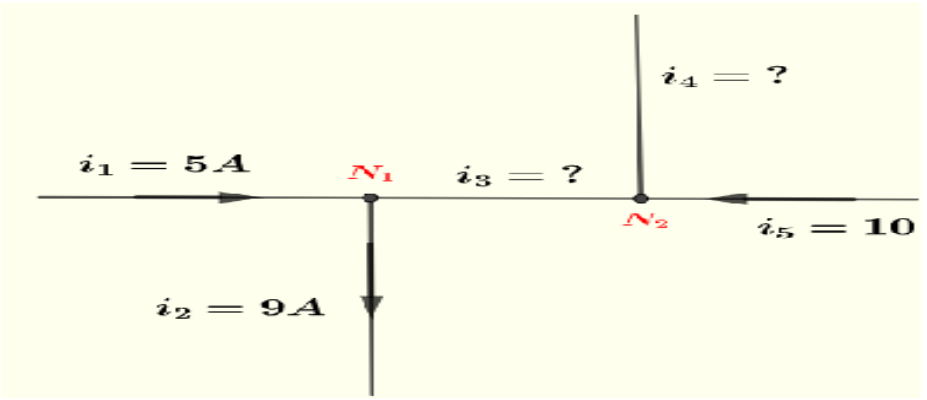
$2 + 9 = I_3 + 4$

$I_3 = 2 + 9 - 4 = 7$ A



Example 2

For the circuit, use KCL to find the branch currents I_3 and I_4:



The Solution

That the direction of I1 and I3 **Inter** to the node (n1):

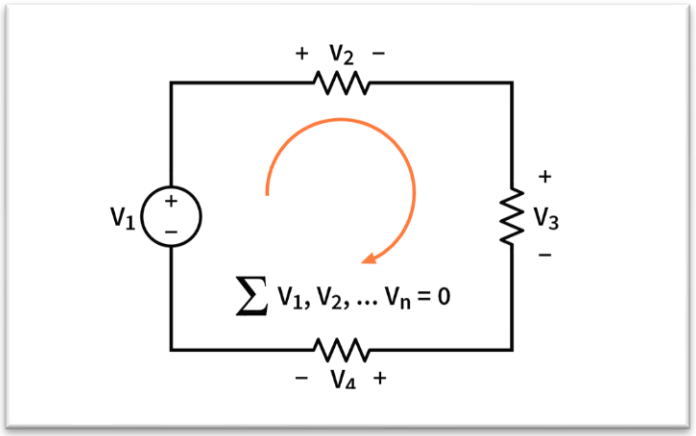
$I_1 + I_3 = I_2$ ⟶ $5 + I3 = 9$ Then : $I_3 = 9 - 5 = 4A$

That the direction of I3 and I4 **out** to the node (n2):

$I_3 + I_4 = I_5$ ⟶ $4 + I_4 = 10$ Then : $I_4 = 10 - 4 = 6\ A$

Kirchhoff's Voltage Law (KVL)

Kirchhoff's voltage law (KVL) states that the sum of all voltages around a closed path (or loop) is zero.

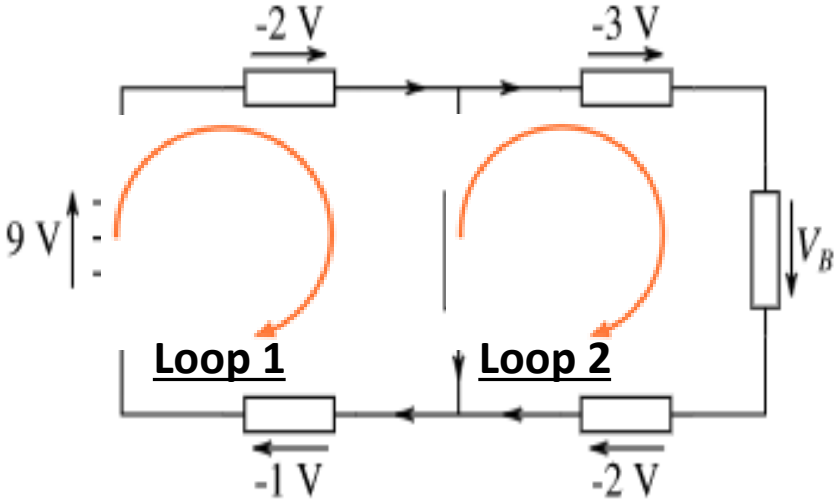


Mathematically,

$$\sum_{m=1}^{M} v_n = 0$$

Example 1

For the circuit diagram below, use Kirchhoff's voltage law to find V_A and V_B:



We can start with any branch and go around either clockwise or counterclockwise .
Here we have 2 loops, Suppose we start with the voltage source and go clockwise around the loop as shown:

Solution

For Loop 1:

$9 - 2 - 1 + V_A = 0$ Then : $V_A = -9 + 2 + 1 = -6$ V

For Loop 2:

$V_B - 2 + V_A - 3 = 0$ Then : $V_B = -6 + 2 + 3 = -1$ V

Thank you