2024Q8

CIRCUITS, CURRENT

It's time for another edition of Wind Studies, and this week, we're exploring the world of circuits! Circuits are one of the most basic parts of any electrical system. A circuit is simply a path that allows electricity to flow. This path can be made of anything that conducts electricity, like copper wires, metal sheets, or even air! The electricity is carried by tiny particles called electrons that are so small that you can't even see them with a microscope.

Have you ever walked across the carpet or touched something made of metal and felt a little spark? That's the result of charged electrons!

The speed at which electrons flow through a circuit is called current. We represent current with an "I" in equations, and it's measured in amperes, often called amps or "A." You can think of current like water flowing through a river, with electrons moving together through the circuit. When different paths of current meet at a point, we call that point a node. According to Kirchoff's Current Law, the amount of current going into a node must equal the amount coming out. This rule can be written as an equation:

$$Kirchoff's\ Current\ Law: \quad \Sigma I_{in} = \Sigma I_{out} \quad or \quad \Sigma I_{in} - \Sigma I_{out} = 0$$

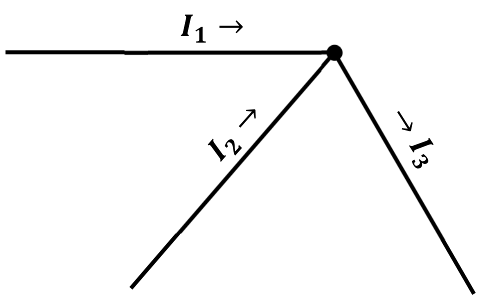

Figure 1: Example diagram of a node and its associated currents

Since I_1 and I_2 are pointing **toward** the node, they're a part of I_{in} or current going into a node.

Similarly, since I_3 is pointing **away from** the node, it's a part of I_{out} or current flowing out of a node.

For these problems, we will treat I_{in} as positive numbers and we will treat I_{out} as negative numbers.

$$I_{in} - I_{out} = 0$$

$$I_1 + I_2 + I_3 = 0$$

This equation can then be used to calculate any of the included current values if you know the other two!

Using Figure 1 and the following current values, we can solve for the unknown current value.

$I_1 = 7\ Amps$

$I_2 = ?\ Amps$

$I_3 = -10\ Amps$

$$I_{in} = I_{out}$$

$$I_{in} = I_1 + I_2 = 7 + ?\ Amps$$

$$I_{out} = I_3 = -10\ Amps$$

$$I_1 + I_2 + I_3 = 0$$

$$7 + ? - 10 = 0$$

$$7 + 3 - 10 = 0$$

$$I_2 = 3\ A$$

Level 1: Calculate the current I_2 for each node using Figures 2 and 3 below, along with the defined values:

$I_1 = -3.6\ A$

$I_2 =$ __ A

$I_3 = 2.7\ A$

$I_4 = 1.5\ A$

$I_5 = 4.3\ A$

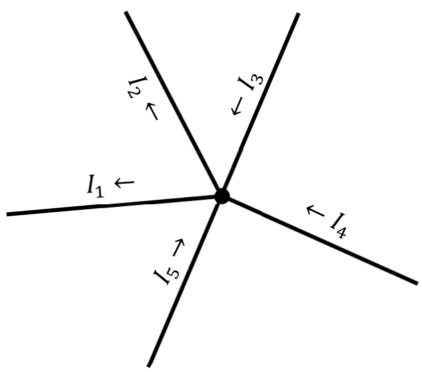

Figure 2: A node with 5 currents flowing into and out of it

$I_1 = -3.6\ A$

$I_2 =$ __ A

$I_3 = -2.7\ A$

$I_4 = 1.5\ A$

$I_5 = -4.3\ A$

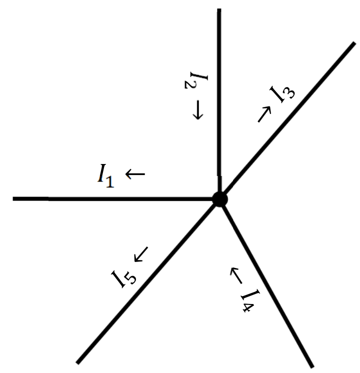

Figure 3: A node with 5 currents flowing into and out of it

Level 2: Using Figure 4, calculate all unknown currents in the circuit diagram when given the values. Note that positive and negative currents are relative to which node being observed. For example, the top left node has I_2 and I_1 going in and I_3 going out. You can call all values positive as long as you pay attention to when to add or subtract them.

$I_1 =$ __ A

$I_2 = 0.8\ A$

$I_3 = 1.2\ A$

$I_4 = 1.7\ A$

$I_5 =$ __ A

$I_6 =$ __ A

$I_7 =$ __ A

$I_8 =$ __ A

$I_9 = 0.5\ A$

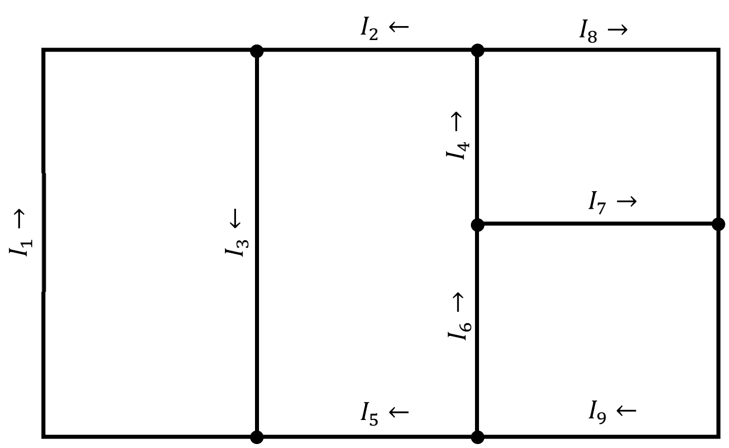

Figure 4: A circuit diagram with 6 nodes and 9 individual currents.