EE101/121

Department of Electronic Engineering, Maynooth University

Section 3 - Voltage and Current

Worked Examples

1 Resistance Calculations

Example 1

The two resistors are in series, so according to our circuit rules the total (equivalent) resistance (their net effect) is found by simply adding their individual values, i.e.

$$R_{\text{tot}} = R_1 + R_2. \tag{1}$$

The total resistance is therefore 300Ω. Using Ohm's law, we know that

$$I = \frac{V}{R}, \tag{2}$$

where V is the voltage supplied by the battery to the circuit (5 V here), R is the total resistance offered by the circuit (calculated above) and I is the current flowing in the circuit, which is what we are looking for. We have then that $I = \frac{5}{300} = 0.0167A = 16.7mA$. This is the current flowing at any point in the circuit, since it is purely a series circuit. Note that we could replace the two resistors with one 300Ω resistor and the same current would flow.

Example 2

In this example the resistors are in parallel. Our circuit rules state that we can represent the combined effect of these resistors with one resistor whose value is given by

$$\frac{1}{R_{\text{tot}}} = \frac{1}{R_1} + \frac{1}{R_2}. \tag{3}$$

The equivalent resistance of the circuit is therefore given by $\frac{1}{R_{\text{tot}}} = \frac{1}{100} + \frac{1}{200} = 0.0150$. This figure is "one over" the resistance (called its reciprocal). The resistance is therefore found as $R_{\text{tot}} = \frac{1}{0.015} = 66.67\ \Omega$. This is the total equivalent resistance of the circuit, and so using Ohm's law with the battery voltage and this resistance will give us the current flowing from the battery which is $I = \frac{V}{R_{\text{tot}}} = \frac{5}{66.67} = 75\ mA$.

There are several ways to calculate the currents flowing through each resistor. One way (and we know enough to be able to do it now) is to remember that in a parallel circuit, the total voltage across parallel arms is the same. Thus, the voltage across each resistor equals the battery voltage (5 V). Knowing this, the current through each resistor can be found. These two currents should add to the current flowing from the battery, as this current splits into two parts to supply the two arms. Verify this.

Example 3

This example requires us to find the current flowing from the battery, so we must find the overall resistance of the circuit as seen by the battery. The two vertical resistors in the diagram are in parallel with each other. Using the result from example 2 (it uses the same resistors), we know that we can replace these two parallel resistors with one resistor of value 66.67Ω. If you draw this out, the new resistor should be in series with the battery and the 100 Ω resistor. The total resistance is therefore found by adding this resistor and the equivalent parallel resistor together, giving a total circuit resistance of 166.67 Ω. Using Ohm's law, the current flowing in the circuit is therefore $I = \frac{5}{166.67} = 30\ mA$.

Example 4

This example is also a combination of series and parallel resistances, and we are looking for the total current flowing from the battery so we need to find the overall resistance of the circuit. Looking at the diagram, the 'top' 100Ω and the 200Ω resistors are in series (connected by a two path node), so these can be replaced by a single 300Ω resistor. This equivalent resistor is connected across both nodes of the 200Ω resistor on the left, and so the equivalent resistor and the 200Ω resistor on the left are in parallel. The equivalent resistance of the circuit is therefore given by

$$\frac{1}{R_{\mathrm{tot}}} = \frac{1}{200} + \frac{1}{300} = 0.0083 \rightarrow R_{\mathrm{tot}} = \frac{1}{0.0083} = 120.4819\ \Omega. \tag{4}$$

Using Ohm's law, the current in the circuit is found to be $I = \frac{5}{120.4819} = 51.5\ mA$.