Basic Circuit Analysis

For current to flow, a circuit must be closed, conventional direction of current is from +ve to -ve. The current flowing a circuit is constant. The flow of current is defined as

$$I = \frac{dQ}{dt}$$

The units of current are **Ampere** (**A**), we say 1 A of current is flowing through a circuit if 1 Coulomb of charge is passing through every second.

Kirchoff's current law

The algebraic sum of currents entering /leaving a node is zero. As illustrated in figure **??**.

$$I - I_1 - I_2 + \cdots - I_6$$

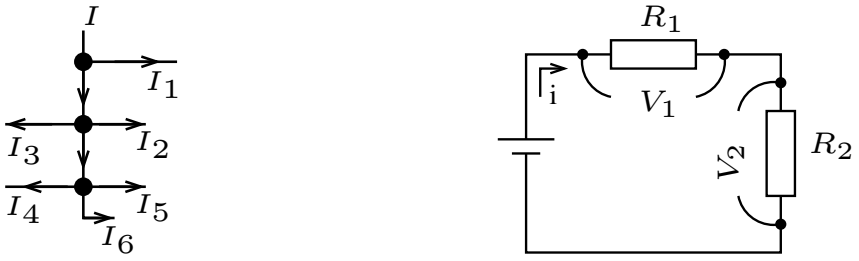
Since current I is entering the node it is +ve, while all other currents are leaving the node they are -ve. Equivalently we may write

$$I = I_1 + I_2 + \cdots + I_6$$

Kirchoff's voltage law

The algebraic sum of voltages around a closed loop is zero. As illustrated in figure **??**.

$$V - IR_1 - IR_2 - IR_3 = 0$$



(a) KCL (b) KVL

Figure 1: Illustration for Kirchoff's current and voltage laws.

Voltage Divider Rule

For a circuit illustrated on the side

$$i = \frac{v}{r_1 + r_2}$$

$$v_1 = v\frac{r_1}{r_1 + r_2}$$
$$v_2 = v\frac{r_2}{r_1 + r_2}$$

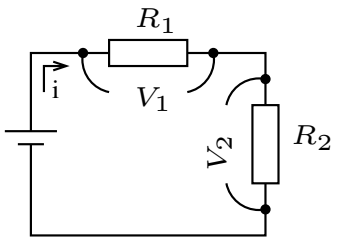


Figure 2: A series circuit.

for a general series circuit with n-resistors

$$v_k = v\frac{r_k}{r_1 + r_2 + \cdot + r_n}$$

Current Divider Rule

For a circuit illustrated on the side

$$I_1 = \frac{V}{R_1}$$
$$I_2 = \frac{V}{R_2}$$

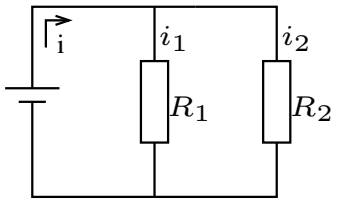


Figure 3: A parallel circuit.

According to Ohm's law $V = IR$ in this configuration $R_1||R_2$.

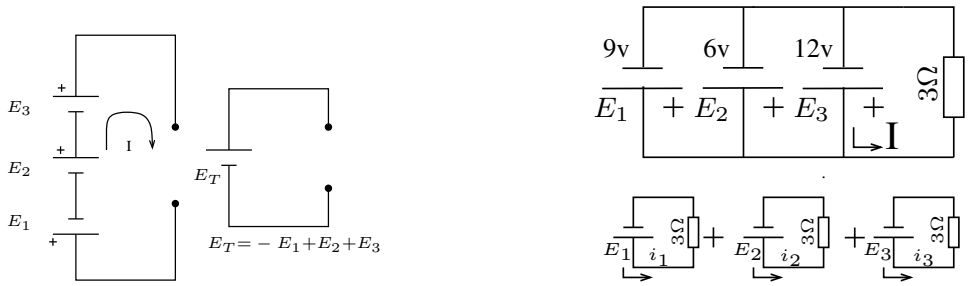
$$i_1 = \frac{v}{R_1} = \frac{i}{R_1}\frac{R_1R_2}{R_1 + R_2} = i\frac{R_2}{R_1 + R_2}$$
$$i_2 = \frac{v}{R_2} = \frac{i}{R_2}\frac{R_1R_2}{R_1 + R_2} = i\frac{R_1}{R_1 + R_2}$$

for a general parallel circuit with n-resistors

$$i_k = i\frac{\frac{1}{R_k}}{\frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_N}}$$

Superposition of Sources

It is important to note that if voltage sources are arranged in series, the resultant source is the algebraic sum of the sources (while keeping track of the polarity) as illustrated in figure 3 . However when voltage sources are connected in parallel, the effect source can be studied by considering each voltage source separately as illustrated in figure 3.



(a) Series Configuration.

(b) Parallel Configuration.

Figure 4: Effect of voltage sources when in series and parallel configuration.