Aula 1: Resistive Circuits

Prof. Marcelino Andrade

Faculdade UnB Gama

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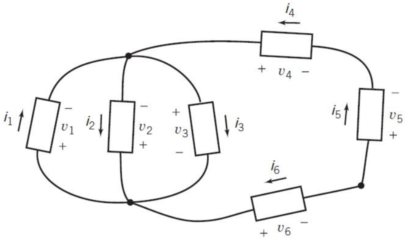
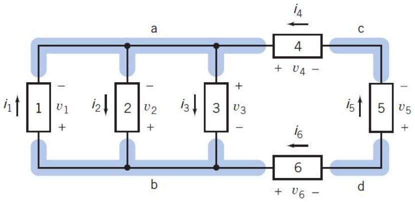
Contents

Introduction to Electric Circuits 9th Edition by James A. Svoboda, Richard C. Dorf

Resistive Circuits

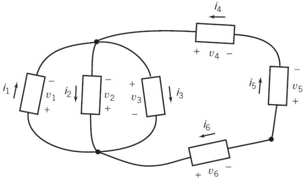




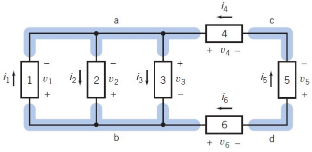
- An electric circuit consists of circuit elements that are connected together.
- The same circuit can be drawn in several ways.
- The places where the elements are connected to each other are called nodes.

Resistive Circuits

We say that circuit drawings A and B represent the same circuit when the following three conditions are met.



(A)



(B)

- There is a one-to-one correspondence between the nodes of drawing A and the nodes of drawing B.
- There is a one-to-one correspondence between the elements of drawing A and the elements of drawing B.
- Corresponding elements are connected to corresponding nodes.

Kirchhoff's Laws

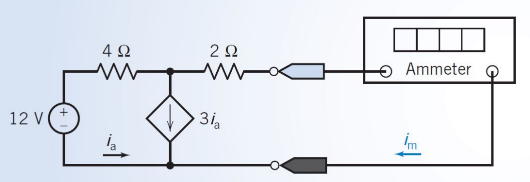
In 1847, Gustav Robert Kirchhoff, a professor at the University of Berlin, formulated two important laws that provide the foundation for analysis of electric circuits.

- **Kirchhoff's current law (KCL):** The algebraic sum of the currents into a node at any instant is zero.
- **Kirchhoff's voltage law (KVL):** The algebraic sum of the voltages around any loop in a circuit is identically zero for all time.

Kirchhoff's laws are a consequence of conservation of charge and conservation of energy.

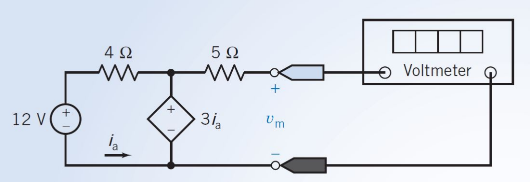
Kirchhoff's Laws

E X A M P L E 3.2-4 - Ohm's and Kirchhoff's Laws



- Determine the value of the current, in amps, measured by the ammeter.

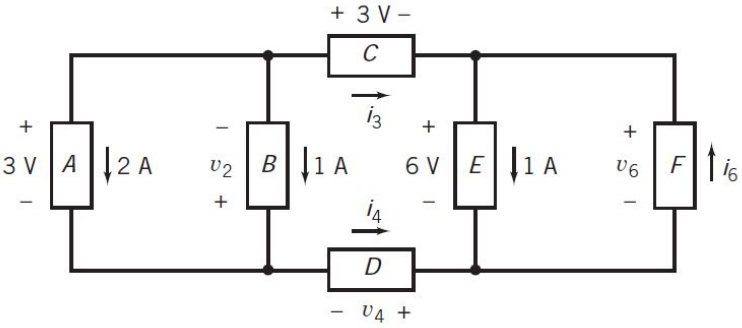
E X A M P L E 3.2-5 - Ohm's and Kirchhoff's Laws



- Determine the value of the voltage, in volts, measured by the voltmeter.

Kirchhoff's Laws

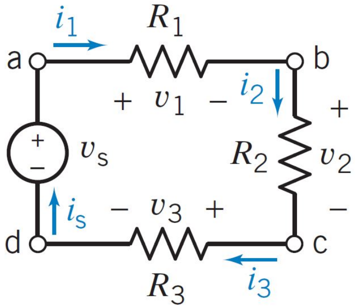
EXERCISE 3.2-1 - Determine the values of i_3, i_4, i_6, v_2, v_4 *and* v_6.



Answer:$i_3 = -3A, i_4 = 3A, i_6 = 4A, v_3 = -3V, v_4 = -6V, v_6 = 6V$

Series Resistors and Voltage Division

Let us consider a single-loop circuit ...



Single-loop circuit with a voltage source v_s.

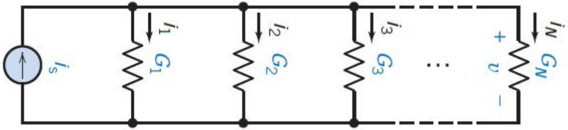
In general, we may represent the voltage divider principle by the equation:

$$v_n = \frac{R_n v_s}{R_1 + R_2 + \ldots + R_N} \quad (1)$$

where v_n is the voltage across the nth resistor of N resistors connected in series.

Parallel Resistors and Current Division

Consider the circuit with N conductors and a current source ...



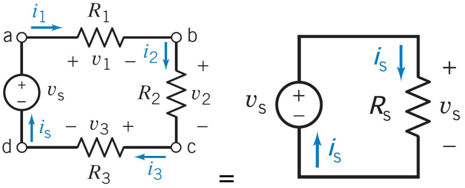
In general, we may represent the current divider principle by the equation:

$$i_n = \frac{G_n i_s}{G_1 + G_2 + \ldots + G_N} = \frac{G_n i_s}{\sum_{k=1}^{N} G_k}, where\ G_n = \frac{1}{R_n} \tag{2}$$

and i_n is the current across the nth conductor of N conductors connected in parallel and G_n.

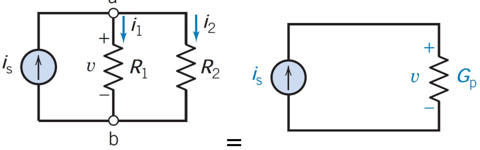
Equivalent Circuit

- Equivalent circuit for a series resistors



$$R_s = R_1 + R_2 + \ldots + R_N = \sum_{n=1}^{N} R_n \qquad (3)$$

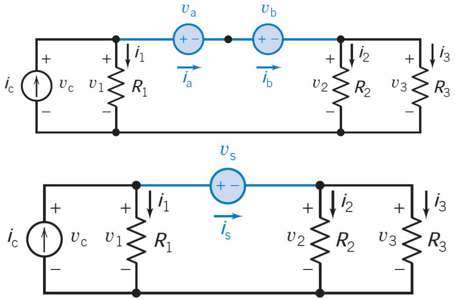
- Equivalent circuit for a parallel resistors

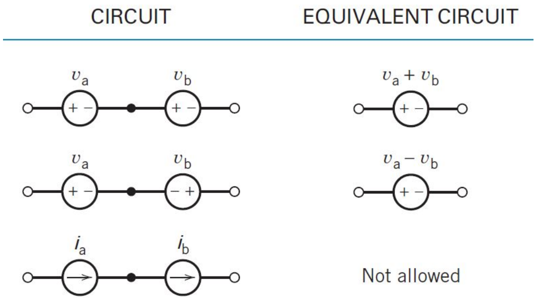


$$G_p = \frac{1}{R_p} = \frac{1}{R_1} + \ldots + \frac{1}{R_N} = \sum_{n=1}^{N} \frac{1}{R_n} \qquad (4)$$

Series Voltage Sources

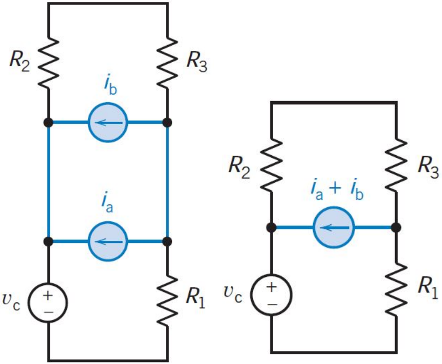
Voltage sources connected in series are equivalent to a single voltage source.

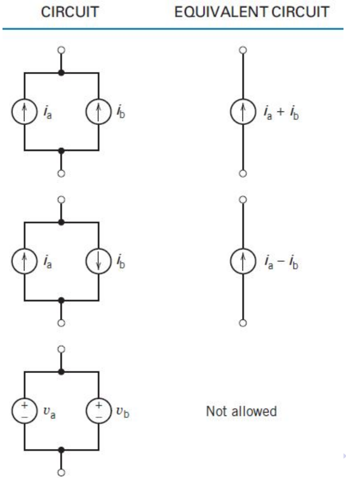




Parallel Current Sources

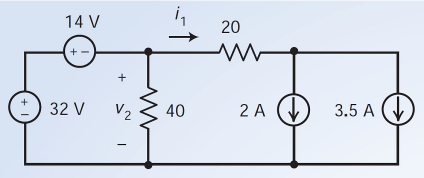
Equivalent current source is equal to the algebraic sum of the currents of the parallel current sources.





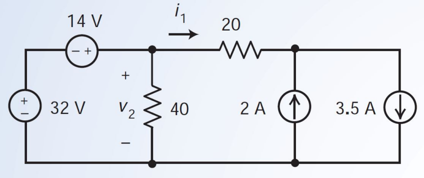
Series and Parallel Sources

E X A M P L E 3.5-1a - Show similar circuits



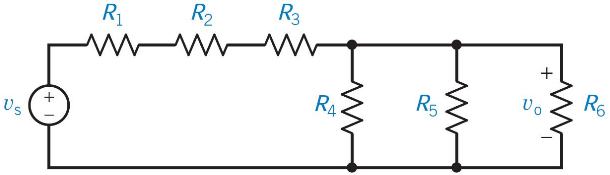
- Determine the value of the current i_1 and voltage v_2.

E X A M P L E 3.5-1c - Show similar circuits

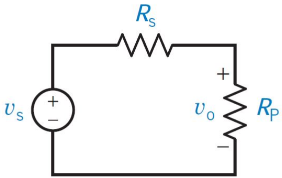


- Determine the value of the current i_1 and voltage v_2.

Analyzing Resistive Circuits



(a) Set of series and parallel resistors.



(b) Equivalent circuit.

$$R_s = R_1 + R_2 + R_3 \tag{5}$$

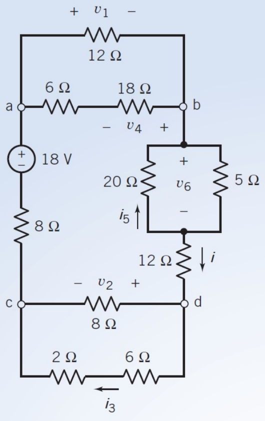
$$R_p = \frac{1}{G_p} \tag{6}$$

$$R_s = R_1 + R_2 + R_3 \tag{7}$$

$$v_o = \frac{R_p}{R_s + R_p} v_s \tag{8}$$

The analysis of a circuit by replacing a set of resistors with an equivalent resistance, thus reducing the network to a form easily analyzed.

Analyzing Resistive Circuits

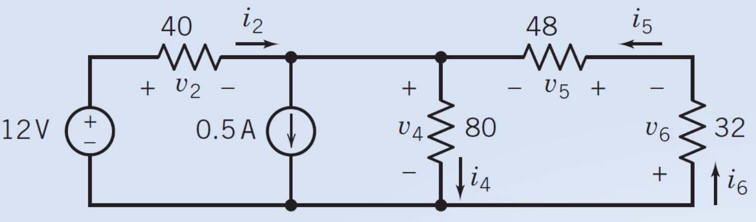


EXEMPLE 3.6-3 - Determine the values of i_3, v_4, i_5 and v_6.

Answer:$i_3 = 0.25A, v_4 = -3V, i_5 = -0.1A, v_6 = 2V$

Analyzing Resistive Circuits Using MATLAB

EXERCISE 3.7-1 - Determine the values of the resistor voltages and currents.



Answer:$i_2 = 0.4A, i_4 = -0.05A, i_5 = 0.05A, i_6 = 0.05A, v_2 = 16V, v_4 = -4V, v_5 = 2.4V$ *and* $v_6 = 1.6V$