EECE 2150: Quiz 1 Notesheet - Sean Balbale - September 18, 2024

1. Basic Circuit Elements

1.1 Resistors

A **resistor** resists the flow of electric charge. The resistance R is a function of size, shape, and material:

$$R = \frac{\rho \ell}{A} = \frac{\ell}{\sigma A}$$

where:

- ρ is the resistivity,
- σ is the conductivity,
- ℓ is the length,
- A is the cross-sectional area.

Ohm's Law: Voltage V, current I, and resistance R:

$$V = IR \quad \text{or} \quad I = \frac{V}{R}$$

Example: A resistor of $10\,\Omega$ has $5\,V$ applied across it. The current is:

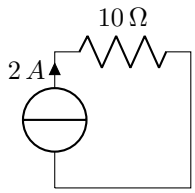
$$I = \frac{5\,V}{10\,\Omega} = 0.5\,A$$

Power Dissipation: The power dissipated by a resistor:

$$P = IV = I^2R = \frac{V^2}{R}$$

Example: If $2\,A$ flows through a $10\,\Omega$ resistor, the power dissipated is:

$$P = I^2R = (2\,A)^2 \times 10\,\Omega = 40\,W$$



1.2 Conductance

Conductance G is the reciprocal of resistance:

$$G = \frac{1}{R} \quad \text{(Siemens, } S = \Omega^{-1}\text{)}$$

1.3 Ideal Conductors

An **ideal conductor** has infinite conductivity $\sigma \to \infty$, and zero resistance $R = 0$.

2. Circuit Laws

2.1 Kirchhoff's Current Law (KCL)

The sum of all currents entering a node equals the sum of all currents leaving the node:

$$\sum_{k=1}^{n} i_k = 0$$

Example: If three currents enter a node ($2\,A$, $4\,A$, $3\,A$) and one current exits (i_x):

$$2\,A + 4\,A + 3\,A = i_x$$

$$i_x = 9\,A$$

2.2 Kirchhoff's Voltage Law (KVL)

The sum of all voltage drops in a closed loop equals the sum of all voltage rises:

$$\sum_{k=1}^{n} v_k = 0$$

Example: In a loop with three voltage drops ($10\,V$, $8\,V$, $4\,V$) and an applied voltage of $24\,V$:

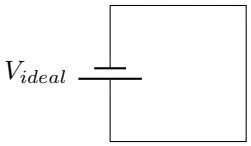
$$10\,V + 8\,V + 4\,V + V_x = 24\,V$$

$$V_x = 2\,V$$

3. Types of Sources

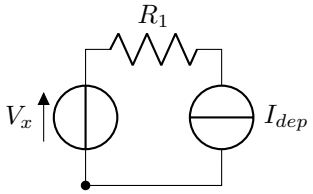
3.1 Ideal Voltage and Current Sources

An **ideal voltage source** maintains a constant voltage regardless of the current. An **ideal current source** maintains a constant current regardless of the voltage across it.



3.2 Dependent Sources

A **dependent source** provides a voltage or current depending on the voltage or current elsewhere in the circuit.



4. Voltage, Current, Power, and Polarity

4.1 Voltage

Voltage V is the electric potential difference between two points in a circuit:

$$v = \frac{dw}{dq}$$

where v is voltage, w is energy, and q is charge.

4.2 Current

Direct Current (DC): A constant current over time.
Alternating Current (AC): A sinusoidal current, e.g., 60 Hz.

4.3 Power

Power is the rate of expending or absorbing energy:

$$P = VI$$

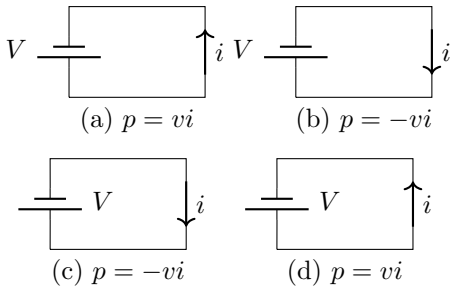
Polarity Reference: - If current enters the positive terminal, the element absorbs power:

$$P = VI$$

- If current enters the negative terminal, the element delivers power:

$$P = -VI$$

4.4 Polarity Reference Diagrams



(a) $p = vi$ (b) $p = -vi$

(c) $p = -vi$ (d) $p = vi$

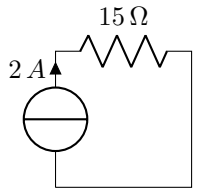
5. Practice Problems

Problem 1: Ohm's Law

A $15\,\Omega$ resistor has a current of $2\,A$. What is the voltage across the resistor?

Solution:

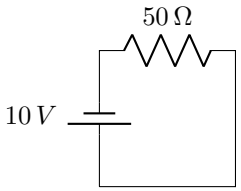
$$V = IR = 2\,A \times 15\,\Omega = 30\,V$$



Problem 2: Power Dissipation

A $50\,\Omega$ resistor has $10\,V$ across it. Find the power dissipated.
Solution:

$$P = \frac{V^2}{R} = \frac{10^2}{50} = 2\,W$$



Problem 3: Kirchhoff's Current Law

At a node, currents of $3\,A$, $4\,A$, and $2\,A$ enter, and a current of $5\,A$ leaves. Find the unknown current i_x.
Solution:

$$3\,A + 4\,A + 2\,A = 5\,A + i_x$$

$$i_x = 4\,A$$