

Basic DC Components

ME 120 Lecture Notes

Portland State University
Mechanical and Materials Engineering

Learning Objectives

Successful completion of this module will enable students to

- Compute power dissipation in simple DC circuits, using Ohm's law
- Compute the equivalent resistance of two resistors in series
- Compute the equivalent resistance of two resistors in parallel
- Reduce resistor networks to an equivalent resistance

Current

Electrical current is caused by the flow of electrons. Current is a flow of electrical charge.

The unit of electrical charge is coulomb (C).

The unit of electrical current is amp (A).

$$1 \text{ A} = 1 \frac{\text{C}}{\text{s}}$$

$$1 \text{ C} = 6.24 \times 10^{18} \text{ electrons}$$

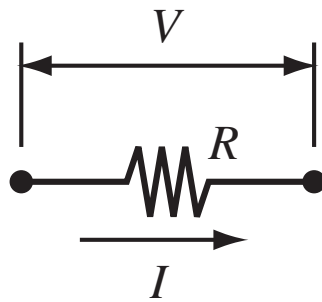
Voltage

Voltage is the energy potential that tends to cause electrical charge to move. It is a measure of the work (or energy) necessary to separate opposite charges.

$$1 \text{ V} = 1 \frac{\text{J}}{\text{C}}$$

Ohm's Law

Ohm's law relates voltage, current and resistance for the flow of current through a conductor.



$$V = I \times R$$

$$1V = 1A \times 1\Omega$$

Power and Energy

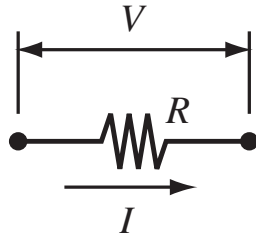
Power:

Power is the rate at which work is done, which is equal to the rate at which energy is expended.

$$P = \frac{\text{Work}}{\text{time}} = \frac{\text{Energy}}{\text{time}} \quad 1W = \frac{1J}{1s}$$

Power

For electrical current:



$$P = V \times I$$

Using Ohm's Law ($V = IR$):

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

Power Limits

All electrical devices have limits on the power they can handle

Too much power consumption will cause a device to fail or "burn out"

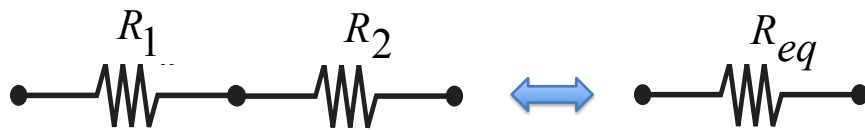
We need to work within the power limits when we design equipment

Equivalent Resistance

Most interesting and useful circuits are a combination of individual components

Resistors in Series

Resistors in series are equivalent to a single resistor having a resistance equal to the sum of the individual resistors.

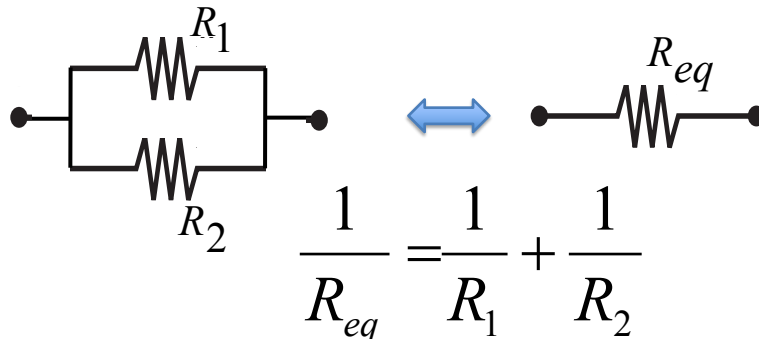


$$R_{eq} = R_1 + R_2$$

Equivalent Resistance

Resistors in Parallel

Resistors in parallel are equivalent to a single resistor having a value obtained by summing the inverse of the individual resistors.



$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$