EEE 202: Circuits I **Fall 2018**

Lecture 2: Circuit Elements and Ohms Law

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2.1 Things to remember

- $I = \frac{dq}{dt}$
- $P = \frac{dw}{dt}$
- $P = \frac{dw}{dt} = \frac{dw}{dq} * \frac{dq}{dt} = VI$

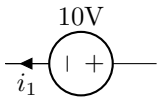


Figure 2.1: Power is absorbing if current is going from + to -

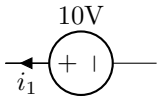


Figure 2.2: Power is supplying if current is going from - to +

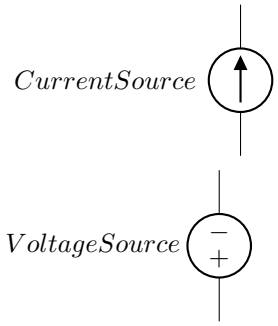
2.2 Elements in a Circuit

In order to build a circuit we need a bunch of elements. Elements in a circuit are either Passive or Active

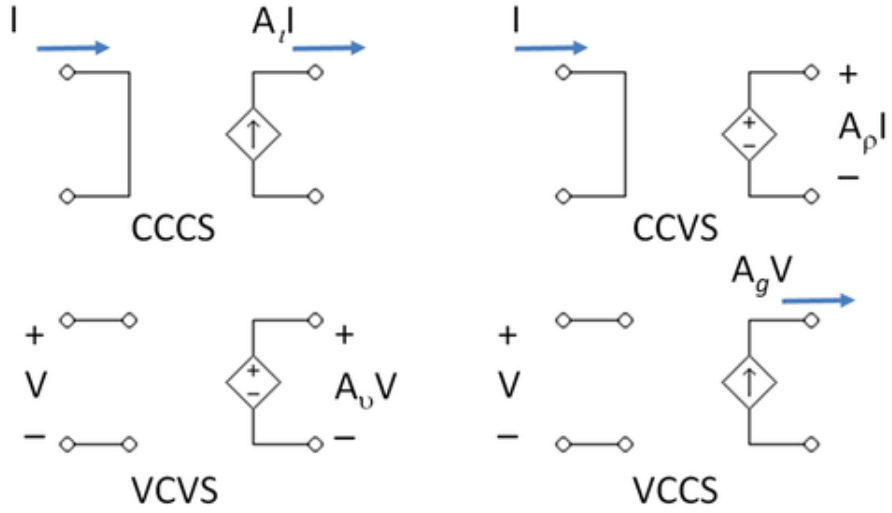
- Passive Elements: Elements that cannot generate energy (e.g., Resistor, Capacitor, Inductor)
- Active Elements: Elements that can actually generate energy (e.g., Voltage/Current Source)

2.2.1 Types of Sources

- Independent Sources: Value does not depend on any other element in a circuit.

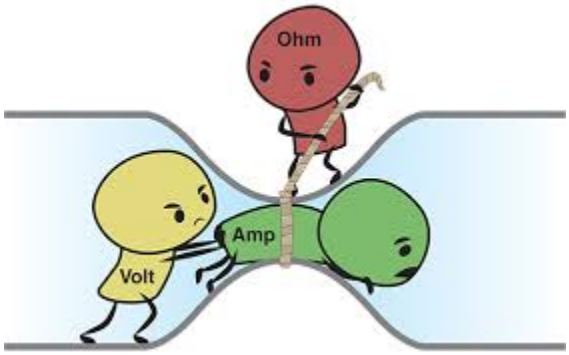


- Dependent Sources: The value of that source is controlled by another source.



1. Voltage Sources that are controlled by a voltage (VCVS)
2. Voltage Sources that are controlled by current (VCCS)
3. Current Source controlled by a voltage (CCVS)
4. Current Source controlled by current (CCCS)

2.3 Ohm's Law (V = IR)



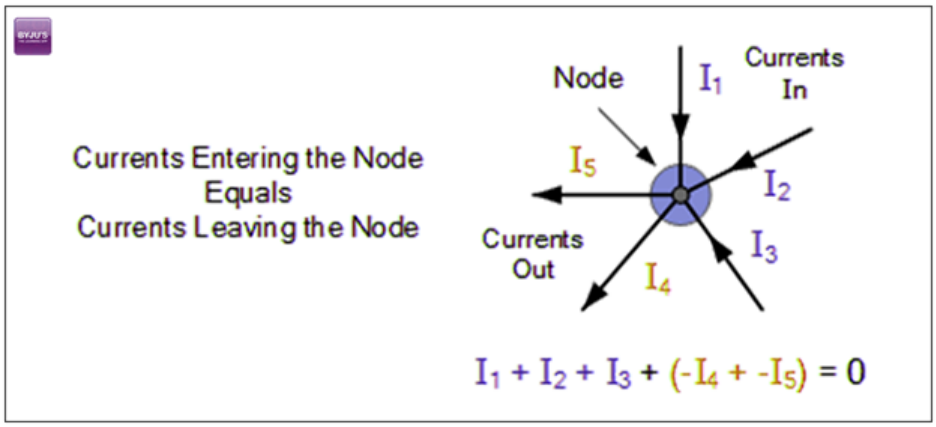
- Resistance (Ω): Opposition to the flow of charge.
- Resistor: Element that impedes or doesn't let element go

- Conductance (S): Inverse of Resistance
  1. $G = \frac{1}{R}$
  2. Measured in siemens
- Relationship between Voltage, Resistance, and Current is through Ohm's Law
  1. $I \propto V$
  2. $I \propto \frac{1}{R}$
  3. $I = \frac{V}{R}$
  4. $P = VI$
- You can find the unknown by knowing 2 of the Ohm's law variables. This also allows us to substitute Ohm's Law into more formulas.
  1. $V = RI \Rightarrow P = (RI)I = RI^2 > 0$
  2. $I = \frac{V}{R} \Rightarrow P = V * \frac{V}{R} = \frac{V^2}{R} > 0$
  3. These two functions are always positive which tells us if we have resistance in a circuit it's always absorbing power not supplying it.

2.4 Kirchhoff Law

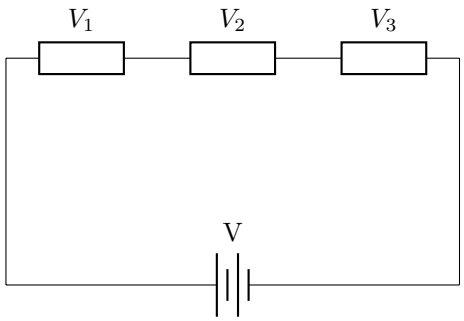
- Node: The portion of a wire that makes up a bunch of elements
- Kirchhoff Current Law: Sum of the current entering the node is equal to the sum of the currents that are leaving. In other words, Algebraic sum of the currents adds up to zero with the following rule:
  - If Current enters a node $\rightarrow (+)$
  - If Current leaves a node $\rightarrow (-)$

Then $\Sigma I = 0$



- Kirchoff Voltage Law: Within any closed loop of a circuit, the sum of all the voltages in any closed loop is always zero with the following rule:
  - Voltage encounters $+ \rightarrow (+)$
  - Voltage encounters $- \rightarrow (-)$

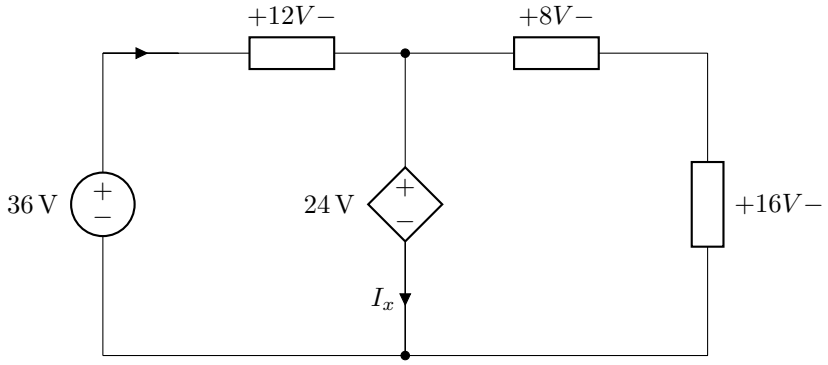
Then $\Sigma V = 0$



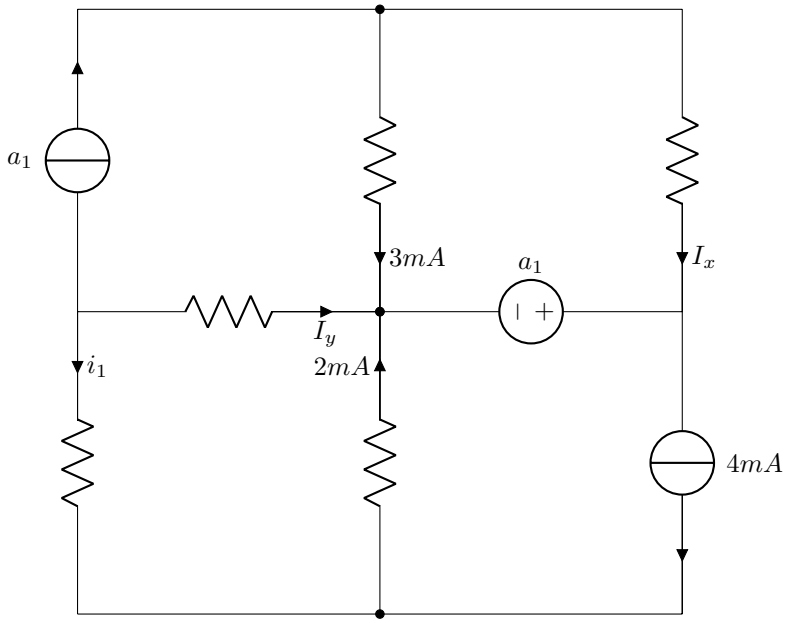
$V = V_1 + V_2 + V_3$

2.4.1 KVL Example

2.4.2 Example 1

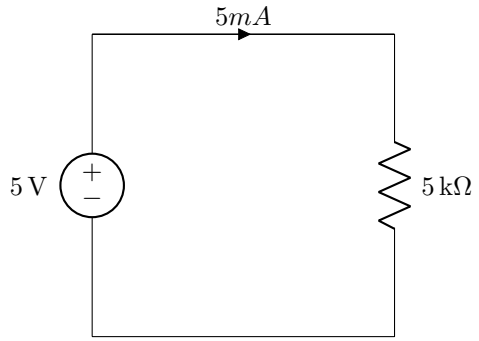


2.4.3 Example 2



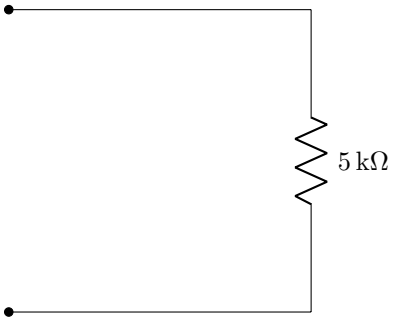
- Power Supplied = Power Absorbed
- P = VI
- P_{36} is supplying power
- $P_{36} = -36 * I_x(absorbing)$
- $P_1 = 12I_x(absorbing)$
- $P_2 = 8I_x(absorbing)$
- $P_3 = 16I_x(absorbing)$
- $P_{2I} = 24 * 2I_x = 48I_x(absorbing)$

2.4.4 Example 3



- $V = RI$
- $V = 5k\Omega * 5mA$
- $V = 5k\Omega * 5mA$
- $V = 5000\Omega * 0.005mA$
- $V = 25V$

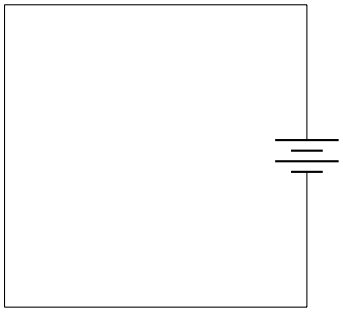
2.4.5 Open Circuit



The figure above shows an open circuit (O.C.). An open circuit is a circuit which has no current flowing through it. Circuits with large resitances can also become open circuits.

- $I = \frac{V}{R}$
- $\frac{V}{\infty} = 0$

2.4.6 Short Circuit



The figure above shows a short circuit. As Ohm's Law states V = RI, since there is no resistance in the circuit, the voltage of the wire is zero.