CENG 215

Circuits and Electronics Lecture Notes

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Chapter 1

Introduction - October 15, 2020

1.1 Abstractions

Recall the Newton's formula $F = ma$, which defines the relationship between force, mass and acceleration. This formula modals acceleration using force and mass. However, according to this model, there is no connection between mass and speed. Consider now, the Einstein's equation:

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{1.1}$$

As this equation shows, speed affects mass. The abstractions ignore certain connections for the sake of simplicity. Likewise, electrical engineering, based on Maxwell's Equations, create abstractions, notably, this lecture deals with the *Lumped Circuit Abstraction*.

Consider a statement in a high level programming language `int n = 3;`, this basic statment goes through many abstractions eventually reaching circuitery.

1.2 Circuits

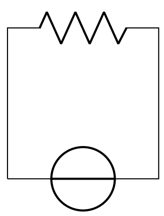
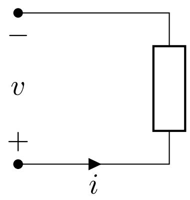


Figure 1.1: A simple cirucit abstraction

From this abstraction, arises the **Ohm's Law**

$$v = iR \tag{1.2}$$

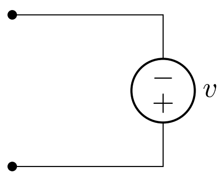
1.2.1 Two Terminal Element



Two terminal elements include batteries, resistors, capacitors, etc...

Battery

Batteries provide voltage and can be bind into serial or paralel.



Below are power (in watts) and energy (in Jouless or watt-seconds) for batteries.

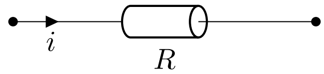
$$P = vi \tag{1.3}$$

$$w = Pt \tag{1.4}$$

Enery formula can also be represented as:

$$w = \int_{t_1}^{t_2} v(t)i(t)\mathrm{d}t \tag{1.5}$$

Resistance



Imagine a generic tube with length l, resistivity ρ and cross sectional area a, in this case, the Resistance of the element R is

$$R = \rho\frac{l}{a} \tag{1.6}$$

The resistance can be showed as:

Where the Ohm's Law state:

$$v = Ri \tag{1.7}$$

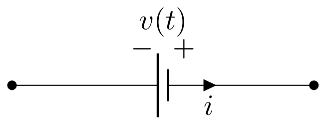
or alternativelly

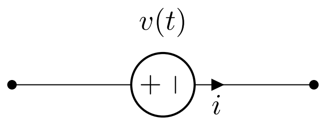
$$i = Gv \tag{1.8}$$

Where G is conductance, whose SI unit is siemens and defined as $\frac{1}{R}$

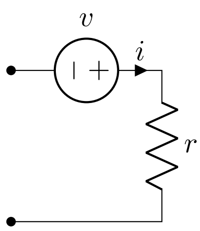
Ideal Voltage Source

Ideal Voltage source can be represnted by:





In general, any voltage soucre can be drawn as



Where r is the internal resistence that arise from the material itself. An ideal voltage source would be able to provide the same current no matter what the voltage is, however this is not possible in real life, where any voltage source has a r