Announcements

✓ **New schedule** has been posted on-line

✓ **Office hours** moved in 463 Cory Hall

✓ No discussions no labs this week!

✓ Would you **move lectures** in 247 Cory Hall?

✓ **HW** will be posted on Friday and will be due by 5PM in 463 Cory Hall the following friday
About Labs

- 010 10
- 012 3
- 013 27
- 014 3
- 015 13
- 010 18
- 013 19
- 015 19
Missing e-mail addresses

name [BAN, IL HYUN]
name [BAZARRAGCHAA, ZORIGT]
name [BESTORY, CORINNE]
name [BROWNING, JASON]
name [CHUNG, HYE WON]
name [JANG, WEON WI]
name [JWA, TAI WOOK]
name [KIM, JU HYUN]
name [KIM, KI SANG]
name [LEEPER, ANDREW ALAN]
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Outline

✓ Basic quantities
  ✓ Charge
  ✓ Current
  ✓ Voltage
  ✓ Power

✓ Basic elements
  ✓ Resistor
  ✓ Voltage Source
  ✓ Current Source
  ✓ Capacitor
  ✓ Inductor

✓ Kirchoff’s Current Law
Charge

✓ Charge are quantized
  ✓ Multiple of $1.602 \cdot 10^{-19}$ Coulomb

✓ Charge conservation principle
  ✓ Electric charge is neither created nor destroyed

✓ Rubbing amber and fur separates charges but the system is still neutral
Voltage

✓ Work done per unit charge to move against an electric field

\[
V_{ab} = V_a - V_b
\]

✓ Remember that voltage is defined with respect to a reference point

✓ Unit of measure Volt (V) = Joule/Coulomb (in honor of Alessandro Volta)
Current

✓ Rate of flow of electric charge

\[ i = \frac{dq}{dt} \left[ \frac{\text{Coulomb}}{\text{sec}} = \text{Ampere} \right] \]

✓ Unit of measure Ampere (A) (in honor of André-Marie Ampère)

✓ Current has polarity and direction
Count charges flowing in the conductor

- Positive charges flowing in the reference direction contribute as positive
- Positive charges flowing against the reference direction contribute as negative
- Negative charges flowing in the reference direction contribute as negative
- Negative charges...
Reference direction

-1 mA

✓ It means that there is a flow of 1 mC of positive charges per second against the reference direction
Reference Polarities

\[ v_{ab} = v_a - v_b = -1.401 \]

\[ v_{ba} = v_b - v_a = 1.401 \]
Power

✓ Change in energy over time

\[ p = \frac{dw}{dt} = \frac{dw}{dq} \frac{dq}{dt} = vi \quad [\text{Volt} \cdot \text{Ampere} = \text{Watt}] \]

✓ A charge q moving through a drop in voltage V loses energy qV
✓ Rate of energy loss depends on number of charges per second, which is current
Sign Convention for Power

Passive sign convention

\[ p = vi \]  
\[ p = -vi \]

- If \( p > 0 \), power is being delivered to the box.
- If \( p < 0 \), power is being extracted from the box.
**Resistor**

*Resistance* is the capacity of a material to impede the flow of electric charge. The circuit element used to model this behavior is the **resistor**.

With the reference direction and polarities shown we get the Ohm’s law

\[ v_{ab} = Ri \quad [V = \Omega \ A] \]

A resistor always absorb power, R is always positive.
Voltage Sources

✓ Independent ideal voltage source

✓ Circuit element that maintains a prescribed voltage across its terminals, regardless of the current flowing in those terminals.

✓ Voltage is known, but current is determined by the circuit to which the source is connected.
**Dependent ideal voltage source**

It is a voltage source whose voltage depends on a voltage or current elsewhere in the circuit.

\[
\begin{align*}
\nu_s &= \mu \nu_x \\
\nu_s &= \mu i_x
\end{align*}
\]

\(\mu\) - control parameter
Current Sources

✓ Independent ideal current source

✓ Circuit element that maintains a prescribed current through its terminals, regardless of the voltage across those terminals.

✓ Current is known, but voltage is determined by the circuit to which the source is connected.
Current Sources

✓ Dependent ideal current source

✓ It is a current source whose current depends on a voltage or current elsewhere in the circuit

\[ i_s = \alpha v_x \]

Voltage-controlled

\[ i_s = \beta i_x \]

Current-controlled
Circuit Nodes and Loop

✓ A node is a point where two or more circuit elements are connected

✓ A loop is a path of circuit elements that starts and ends at the same node and includes other nodes at most once
Kirchoff’s Current Law

✓ The algebraic sum of all the currents at any node in a circuit equals zero.
✓ The sum of all currents entering a node is equal to the sum of all currents leaving a node

\[ i_1 + i_2 - i_3 = 0 \]
\[ i_1 + i_2 = i_3 \]