LECTURE 2

1) Administrative - New lab sections
   - Login/password for grades, etc.
   - Website/blackboard
   - Office hour start next week

TODAY

Chapter 1
1) Idea behind this class
2) Voltage & Current
3) Ideal basic circuit elements
4) Power & Energy

Chapter 2
1) Voltage/current source
2) Ohm's law
3) Building circuit models
4) Kirchhoff’s laws
Chapter 1 - Idea (goal) of this class (EE 100)

90% [Goal: Circuit Analysis

(p.s. not Design/Synthesis)

Example: \( V_A = I \cdot R_1 \) \( V_A + \frac{1}{R_2} \) Find \( V_A \).

Problem: Nonlinear \( \rightarrow \) Talk about it later!

Chapter 1 - Voltage & Current

Voltage

Voltage is defined as the separation of energy.

\[ \text{units: } V = \frac{\text{d}W}{\text{d}Q} \quad (\text{J/C}) \]

Current

Current is defined as the flow of positive charge.

\[ \text{units: } i = \frac{dq}{dt} \quad \text{Ampere} \]
Voltage is like potential energy, that is, voltage is "across" a battery.

Current is like water flowing through a pipe, that is, current flowing through a battery.

Chapter 1 - IDEAL Basic Circuit Elements

Three properties:

1. Has only two terminals (for 99% of the class)
2. Has an i-v relationship (some exceptions exist)
3. Cannot be subdivided further
Aside - Example: Assessing Objective 2

\[ i(t) \]

\[ i(t) = 0 \quad t \leq 0 \]

\[ i(t) = 20e^{-5000t} \quad t > 0 \]

Question: Calculate total charge (in \( \mu C \)) entering the element...

Example 1 (cont'd)

\[ i(t) \]

\[ i(t) \mid t \geq 0 \text{ is} \]

\[ 20e^{-5000t} \quad A \]

\[ \frac{dv}{dt} = \frac{di}{dt} \]

\[ t \rightarrow \infty \]

\[ v = \int i \, dt \]

Note: \( t \rightarrow \infty \) because you want total charge
\[ \int_{-\infty}^{0} e^{-5000t} dt \]
\[ = 20 e^{-5000t} \bigg|_{-\infty}^{0} \]
\[ = 20 \cdot \frac{1}{e^{5000}} = \frac{4}{e^{5000}} \cdot 4 \times 10^{-6} \]
\[ = 4000 \, \mu C \]

Chapter 1 - Power & Sign Convention

Symbol for a resistor: \( V = iR \). Ohm's Law

Resistance unit: Ohm (\( \Omega \))
Why \( I \) is positive convention?

Answer: Because of power

\[
\text{power} = \frac{dv}{dt} = \frac{dv}{dt} \cdot \frac{dg}{dt} \quad \text{[Chain Rule]}
\]

\[
P = V \cdot I \quad \text{Watts}
\]

**SIGN CONVENTION**

We need to distinguish between power absorbed & power released!

1) Device is absorbing 2) Device is releasing energy
because charges are flowing from higher potential to lower potential, lost energy is going into device:

\[ P = v_i \text{ Watts} \]
Dependent Voltage Sources

Example:

\[ V = 5 \text{ V} \]

If \( V_b = 4 \text{ V} \),

\[ V = 2 \text{ V} \]

Voltage elsewhere in the circuit

Similarly, we have current sources

\[ I = 2 \text{ A} \]

\[ I = 3 \ \text{amps} \]

Independent current source

Dependent current source
Circuit Terminology

Node: Point where two circuit elements meet

Loop: If you start at one node & trace a path back to the same node

Examples of circuit

\[ V = 5\, \text{V} \quad V = 2\, \text{V} \]
Ohm's Law describes a circuit.

Note: \( x^2 + y^2 = r \) circle