Lecture 4 - Chapter 3
Chapter 4 intro.

Administrivia: (1) I have office hours on Sunday!
(2) Check celoo website

Today: Finish Chapter 3
[Skip 3.5, 3.6 & 3.7] 😊
Example 2.28
Chapter 4: Introduction
Skip problem 3-30 in HW #2
Recall: Elements in Series

Characteristic: Same currents flowing through elements.

Looking in: \[ R = R_1 + R_2 + R_3 \]
Voltage divider

Circuit which is used to obtain different voltage values from a single supply voltage (important: output voltage < supply)
Goal: Find $V_2$

$V_2 = i R_2$ (Ohm's Law)

$V_2 = V_{in} \cdot \frac{R_2}{R_1 + R_2}$

$\text{Kirchhoff's Voltage Law:} \quad V_{in} = V_1 + V_2$

$V_{in} = i R_1 + i R_2$

$\Rightarrow i = \frac{V_{in}}{R_1 + R_2}$
\[ V_2 = (4 \text{V}) \left( \frac{51 \text{k}}{2 \text{k} + 51 \text{k}} \right) \] (voltage divider)

\[ = 4 \cdot \frac{5}{7} = \frac{20}{7} \approx 2.86 \text{V} \]

Current divider: → Not very practical, good thing to know!
This is the "deal" of voltage dividers:

Voltage divider:

\[ \frac{v_{out}}{v_{in}} = \frac{R_2}{R_1 + R_2} \]

Current divider:

\[ \frac{i_{out}}{i_{in}} = \frac{1}{R_1 + R_2} \]

Series:

Parallel:

Give an example of a circuit with at least one voltage source in which all the elements are in series.
I parallel at the same time. Can prove a circuit like that cannot exist.

< I think this is the only type of circuit???
Parallel: Voltages across every element are the same.

Trick: If you go around a loop once, you hit two elements, they are in parallel.
\[ I_{in} = \frac{V}{R_1} + \frac{V}{R_2} \]

(Ohm's Law)

\[ I_{in} = I_1 + I_2 \] (Kirchhoff)

\[ \frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} \] (parallel resistors formula)
Tip: Intuitively understanding formula

\[ \frac{1}{R_{eq}} = \frac{1}{6} + \frac{1}{6} = \frac{1}{3} \Rightarrow R_{eq} = 3 \Omega = \begin{array}{c} 1A \end{array} \]
Intuitively

\[ i_1 > i_2 \]

\[ \frac{1}{R_{eq}} = \frac{1}{1} + \frac{1}{100} \Rightarrow R_{eq} = \frac{1}{0.01} = 0.99 \]

Notice \( 0.99 < 1 \) - Smallest resistor.

In other words, equivalent resistance better be smaller than the smallest resistance in parallel combination.
Finish deriving current divider

\[ I_{in} = i_1 + i_2 \]

\[ i_1 = \frac{V}{R_1} \]

\[ i_2 = \frac{V}{R_2} \]

\[ I_{in} = \frac{V}{R_1 + \frac{V}{R_2}} \]

\[ V = R_2 I_{in} \frac{R_1}{R_1 + R_2} \]
\[ i_1 = \frac{R_1 i_{in}}{R_1 + R_2} \]

Similarly,
\[ i_2 = \frac{R_2 i_{in}}{R_1 + R_2} \]

Example: Problem 2.28 (p. 61)
(a) Find \( i_0, i_1, i_2 \).
(b) \( i_0 = 0 \text{ A} \). Why?
(c) \( V_{a-o} = 0 \) [No voltage drop]

(2) \( \text{KCL} \): \( i_0 = i_a + i_b \)
\( i_b + i_0 = 0 \Rightarrow i_b = -i_0 \)

(3) \( \text{KCL} \)
\[ V_\Delta = 200 \cdot \left( \frac{12k}{8k + 12k} \right) \]

\[ V_\Delta = 120 \text{ V} \]
\[\begin{align*}
&0.6 + i_1 + i_2 = 0 \\
&i_1 = \frac{V}{9k}, \quad i_2 = \frac{V}{3k} \\
&0.6 + \frac{V}{9k} + \frac{V}{3k} = 0 \\
&\Rightarrow V = -\alpha \text{ volts} \\
\end{align*}\]
Ohm's law: \( i_1 = \frac{-\Delta V}{R L} \) because \( i_1 \) enters negative terminal.

Tip: Don't carry negative sign around.

Most common mistakes: \( i_1 = \frac{\Delta V}{R L} \).
Chapter 4 - Techniques of Circuit Analysis

Section 4.1 - Read. Don't need to know all circuit terminology.

Important: node, branch, ground or reference node.

Next time: Nodal Analysis (Node Voltage method).