Lecture 4 - Chapter 3,
Chapter 4 intro.

Administrivia: (1) I have office hours on Sunday!

→ Check celoo website

Today: → Finish chapter 3
[skip 3.5, 3.6 & 3.7 ☺]

⇓

skip problem 3·30 in HW#2

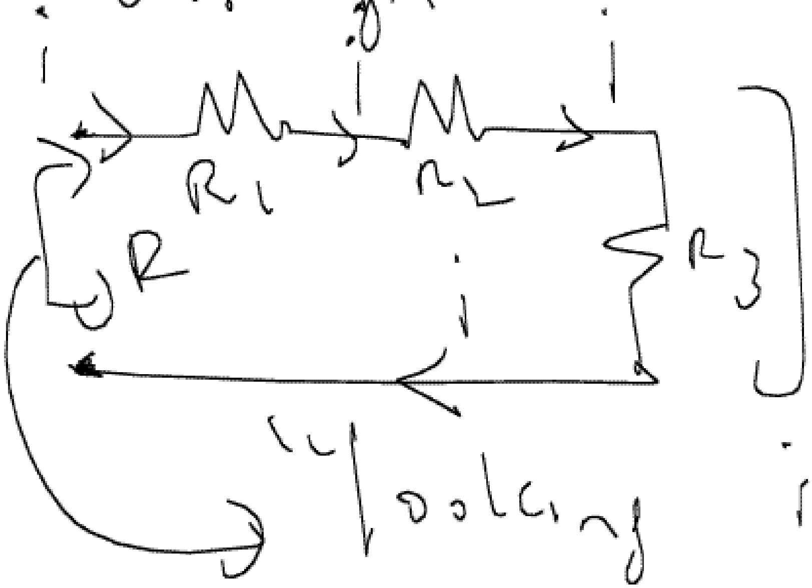
→ Example 2·28

→ Chapter 4: Introduction

→ PSPICE example

Recall: Elements in Series

Characteristic: Same currents flowing through elements:



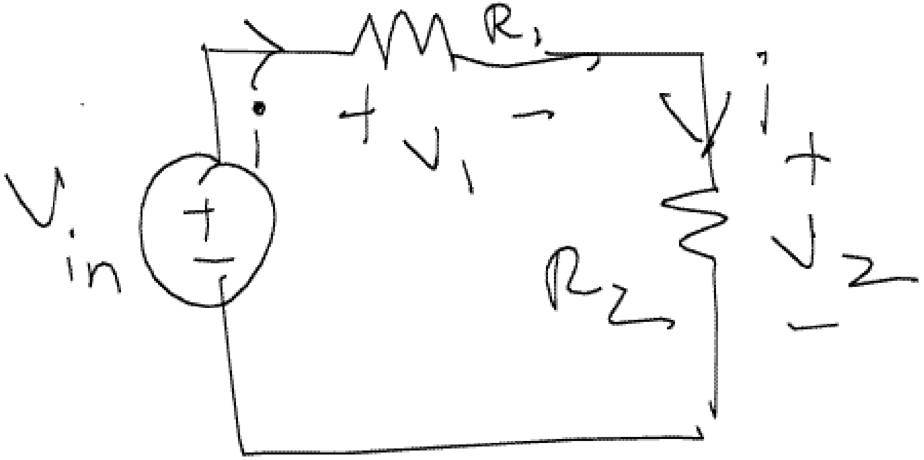
elements in series

$R = R_1 + R_2 + R_3$

Voltage divider

Circuit which is used to obtain different voltage values from a single supply voltage

(important: output voltage < supply)



Goal: Find V_2

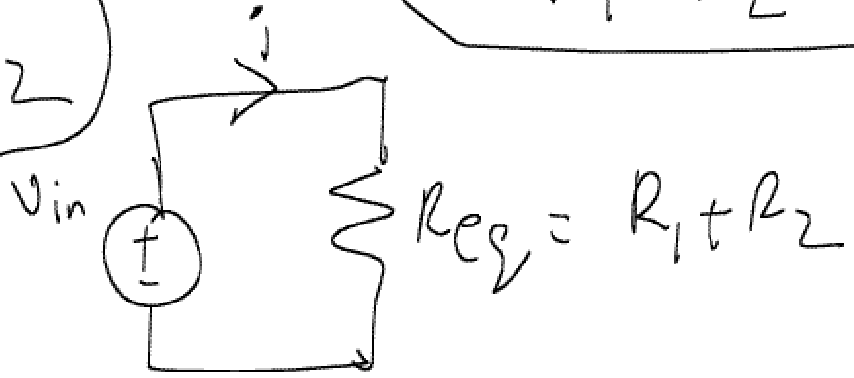
$$V_2 = iR_2 \quad \text{(ohm's law)}$$

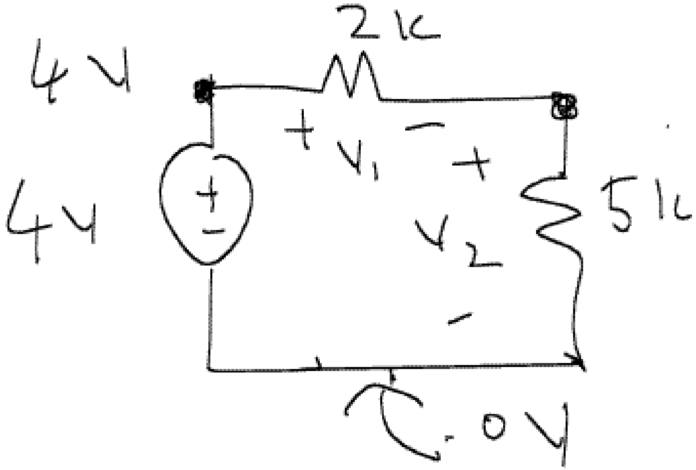
$$\boxed{V_2 = V_{in} \cdot \frac{R_2}{R_1 + R_2}}$$

KVL: $V_{in} = V_1 + V_2$

$$V_{in} = iR_1 + iR_2$$

$$\Rightarrow \quad i = \frac{V_{in}}{R_1 + R_2} \quad \Rightarrow$$





$$V_2 = (4V)\left[\frac{5k}{2k+5k}\right]$$

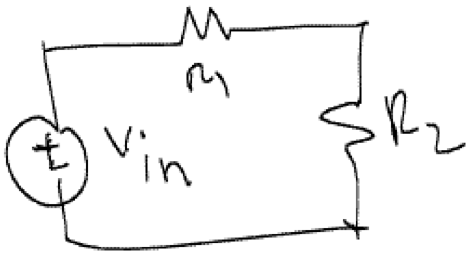
(voltage divider)

$$= 4\cdot\frac{5}{7} = \frac{20}{7} \approx 2.86\,V$$

Current divider: → Not very practical, good thing to know!

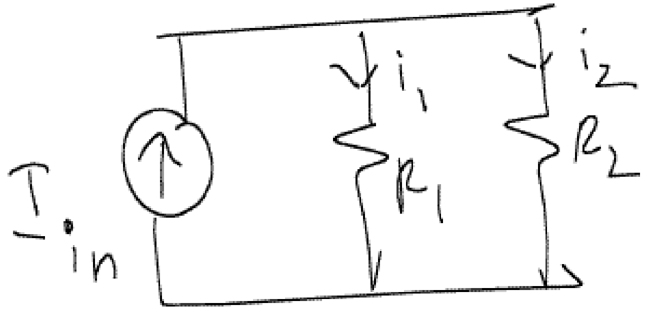
This is the "dual" of voltage divider

Voltage divider



Series

Current divider

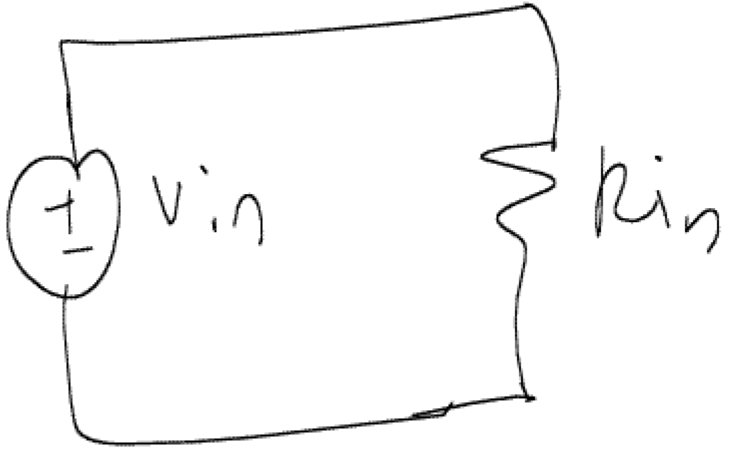


parallel

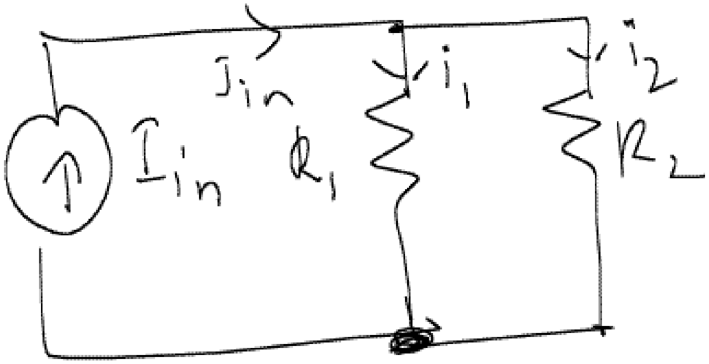
(Q:) Give an example of a circuit with at least one voltage source in which all the elements are in series

& parallel at the same times cos
prove a circuit like that cannot exist.

eg:



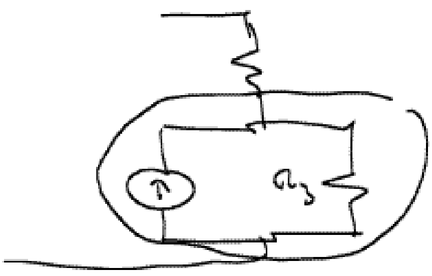
← I think this is the only type of circuits ???

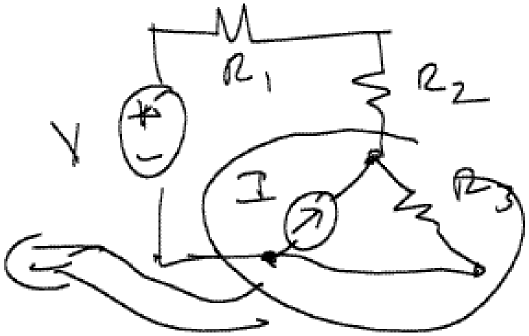


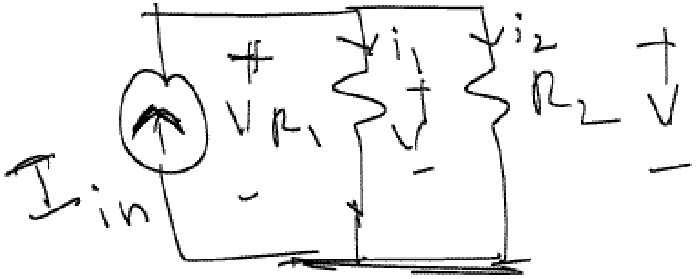
Parallel: voltages across every element is the same.

Trick: If you go around a loop once, you hit two elements, they are in parallel.

eg:







$$i_1 = \frac{V}{R_1}, \quad i_2 = \frac{V}{R_2} \quad \text{Ohm's law}$$

$$I_{in} = i_1 + i_2 \quad (\text{KCL})$$

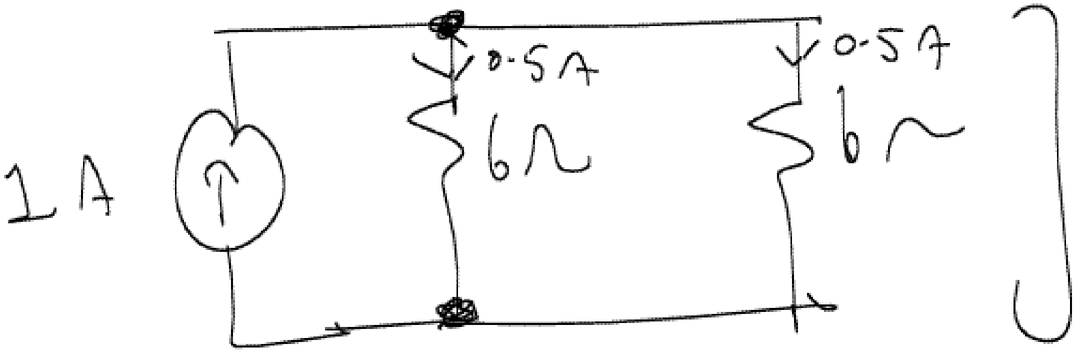
$$I_{in} = \frac{V}{R_1} + \frac{V}{R_2}$$

parallel resistors formula

$$\Rightarrow \frac{1}{R_{eq}} \triangleq \frac{I_{in}}{V} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\Rightarrow \boxed{\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}}$$

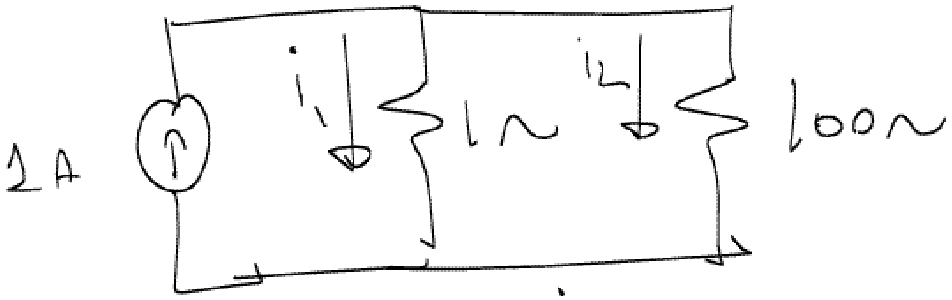
Tip: Intuitively understanding formula



$\Rightarrow 6\Omega \parallel 6\Omega = 3\Omega$

parallel

$\frac{1}{R_{eq}} = \frac{1}{6} + \frac{1}{6} = \frac{1}{3} \Rightarrow R_{eq} = 3\Omega \Rightarrow$



$1\Omega \| 100\Omega \hat{\simeq} 1$
↓
intuitively

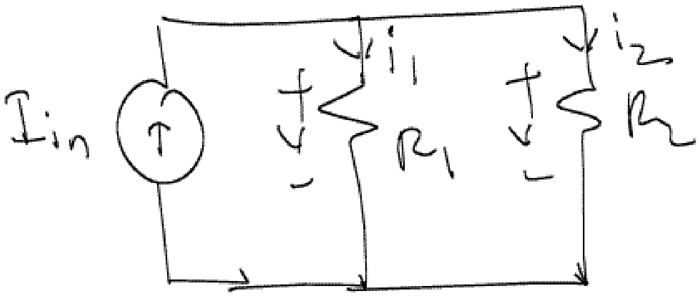
$i_1 >>> i_2$

$$\frac{1}{R_{eq}} = \frac{1}{1} + \frac{1}{100} \Rightarrow R_{eq} = \frac{1}{1.01} \simeq \underline{\underline{0.99\Omega}}$$

Notice $0.99 < 1 \leftarrow$ smallest resistor,

$\boxed{\text{In other words, equivalent resistance better be smaller than the smallest resistance in parallel combination}}$

Finish deriving current divider



$$i_1 = \frac{v}{R_1}$$

$$i_2 = \frac{v}{R_2}$$

$$I_{in} = i_1 + i_2 \Rightarrow I_{in} = \left(\frac{v}{R_1} + \frac{v}{R_2}\right)$$

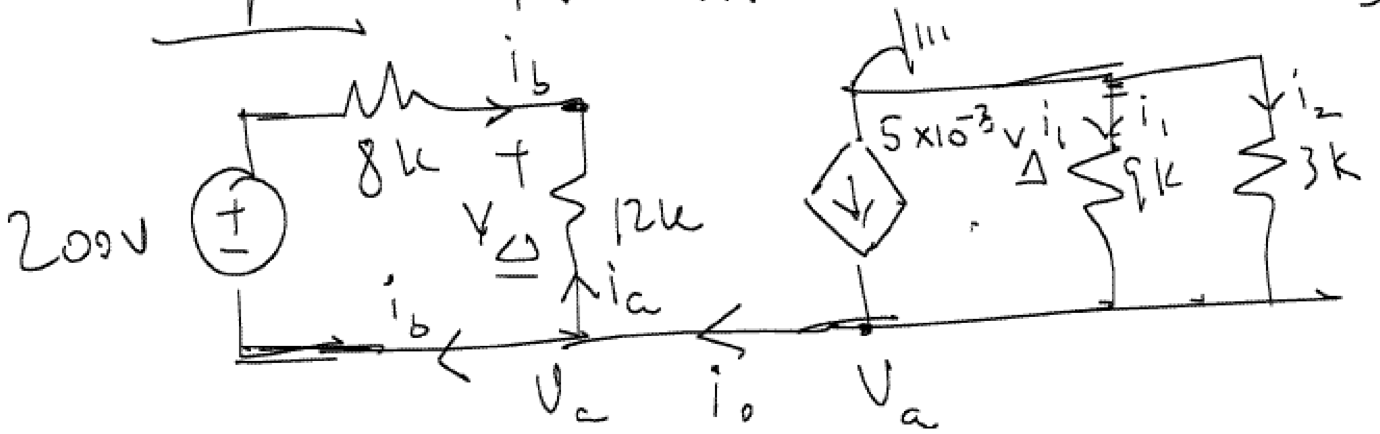
$$\Rightarrow I_{in} = v\left[\frac{R_1 + R_2}{R_1 R_2}\right]$$

$$\Rightarrow v = \frac{R_1 R_2}{R_1 + R_2} I_{in}$$

$$\therefore\ i_1 = \frac{\cancel{R_1}R_2}{R_1+R_2} I_{in} \cdot \frac{1}{\cancel{R_1}} \Rightarrow \boxed{i_1 = \frac{R_2}{R_1+R_2} I_{in}}$$

Similarly, $\boxed{i_2 = \frac{R_1}{R_1+R_2} I_{in}}$

Example: Problem 2-28 (p. 61)



(Q:) Find i_o, i_1, i_2.

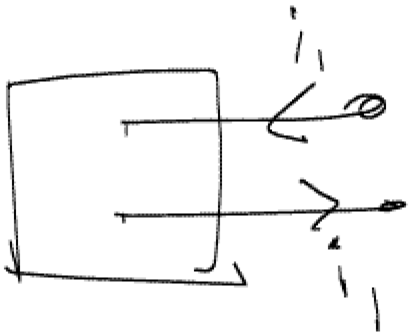
(a) $\boxed{i_o = 0\ A}$. Why? (1) $v_a - v_a = 0$

[no voltage drop]

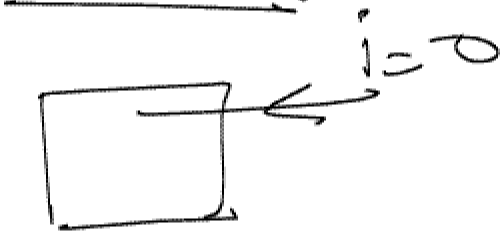
(2) KCL: $i_o = i_a + i_b$ $\quad \boxed{i_o = 0}$

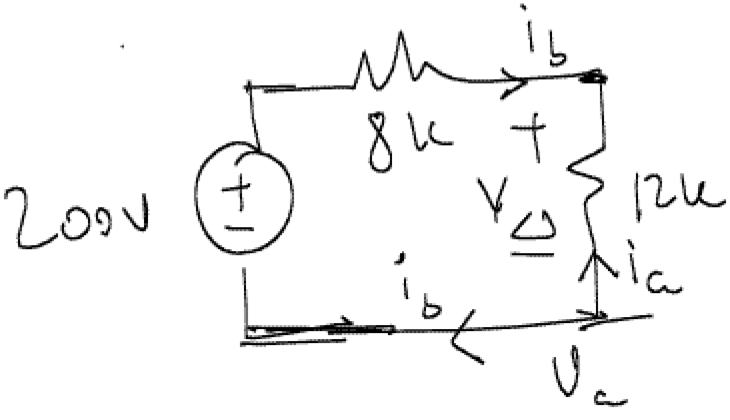
$i_b + i_a = 0 \Rightarrow \boxed{i_b = -i_a}$

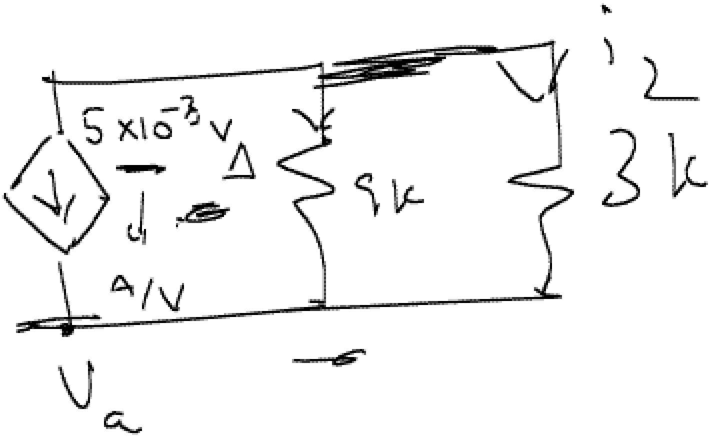
(3)



KCL

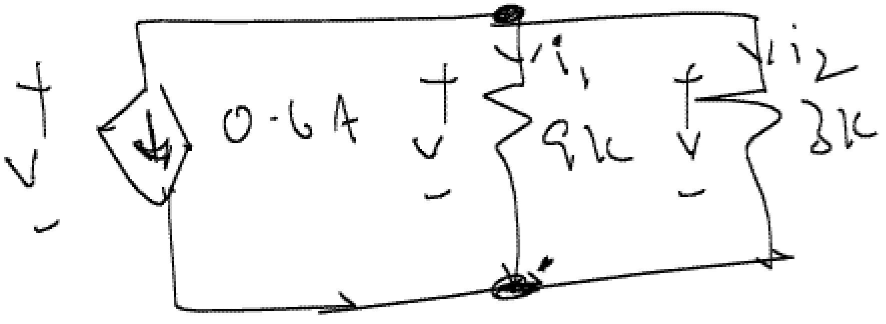






$$V_\Delta = 200 \cdot \left(\frac{12k}{8k+12k}\right)$$ [voltge divider]

$$V_\Delta = 120V$$



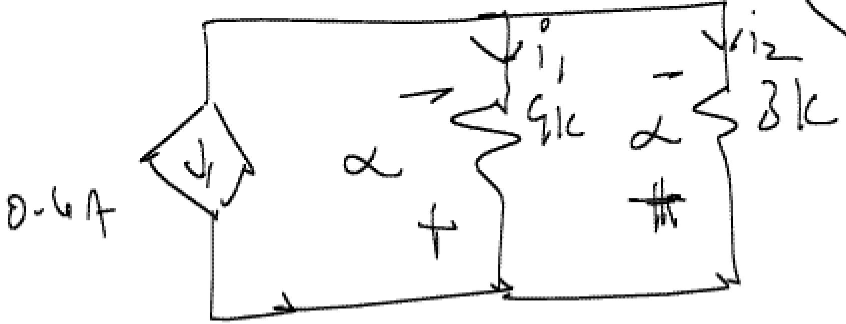
KCL: $0.6 + i_1 + i_2 = 0$

$i_1 = \frac{V}{9k}$, $i_2 = \frac{V}{8k}$

$\therefore \quad 0.6 + \frac{V}{9k} + \frac{V}{8k} = 0$

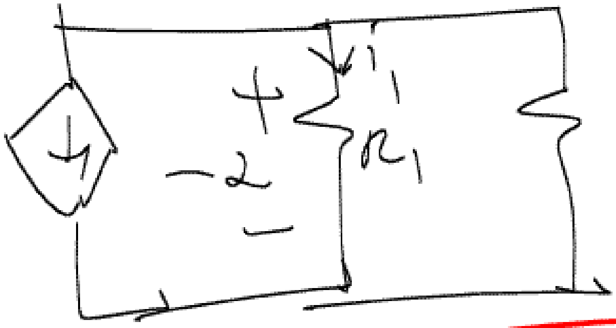
$\Rightarrow \quad V = -\alpha$ volts

This means!



Ohm's law: $i_1 = \frac{-\alpha}{5k} \leftarrow$ Because i_1 enters negative terminal.

(or)



Ohm's law: $i_1 = + \left(\frac{-\alpha}{R_1} \right)$

Most common mistake: $\cancel{i_1 = \frac{\alpha}{5k}}$

Tip: Don't carry negative sign around

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 or Node Voltage method.