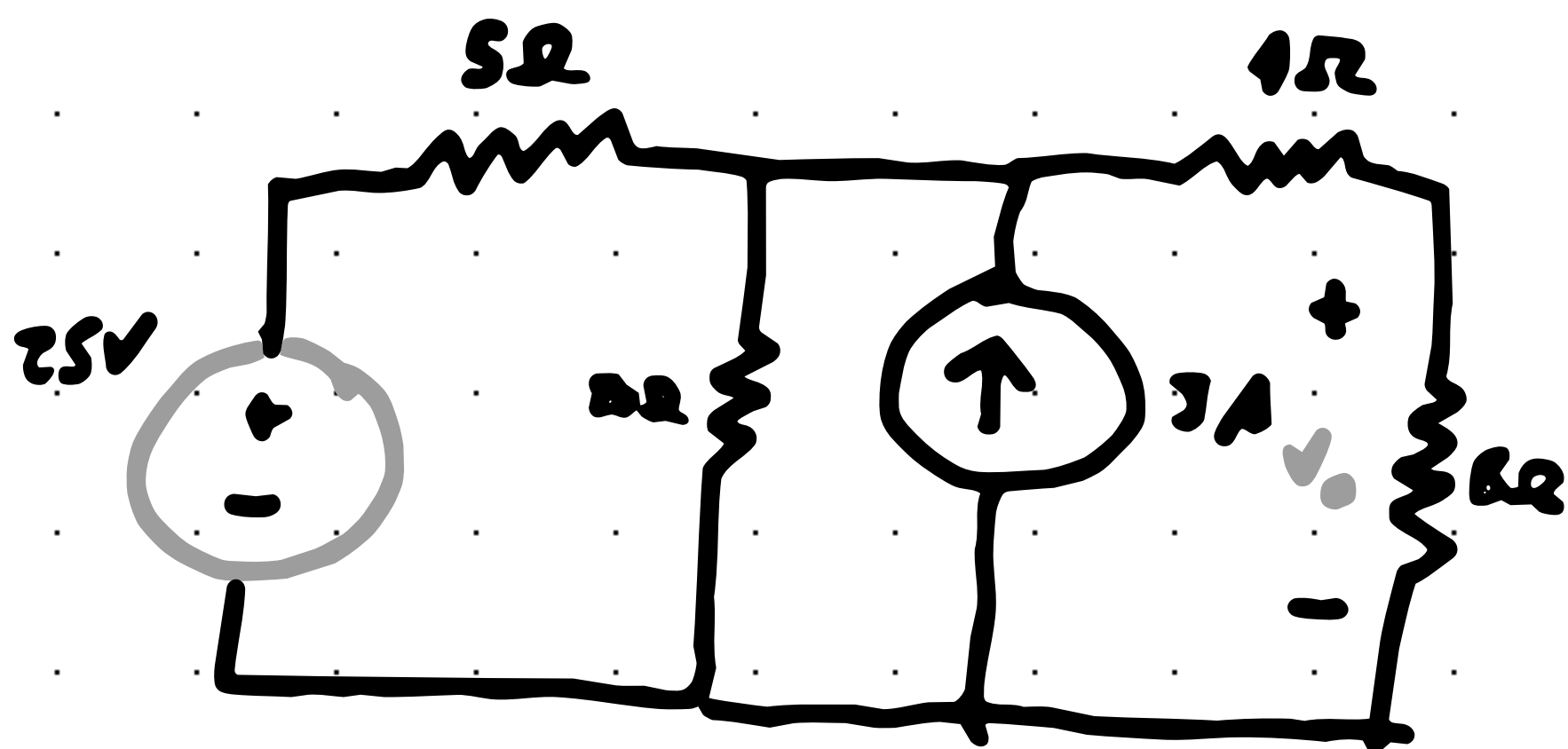


5

Superposition Theorem

A linear circuit excited by multiple sources will have a response which is the sum of the individual responses.

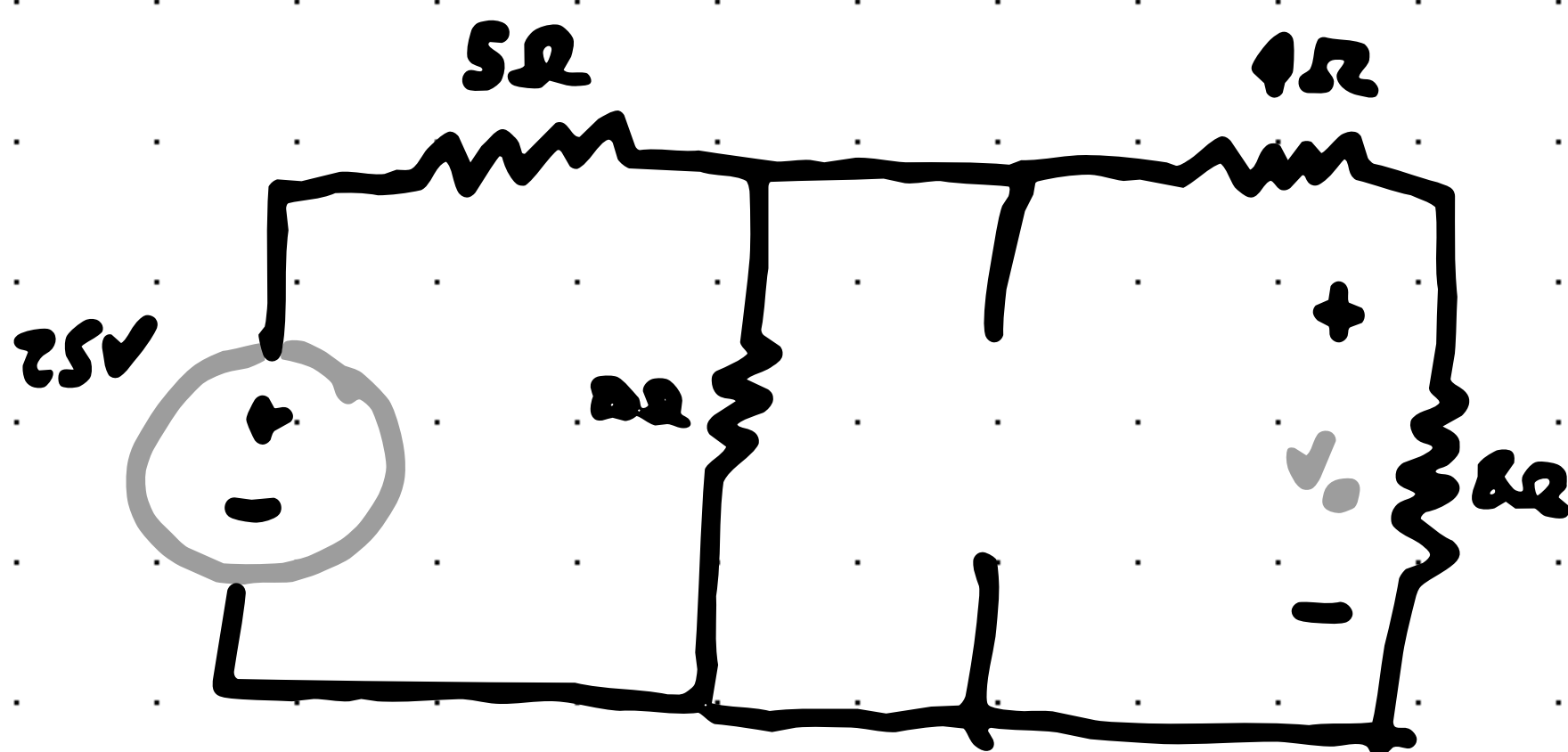
Ex: Find V_o using the Superposition theorem



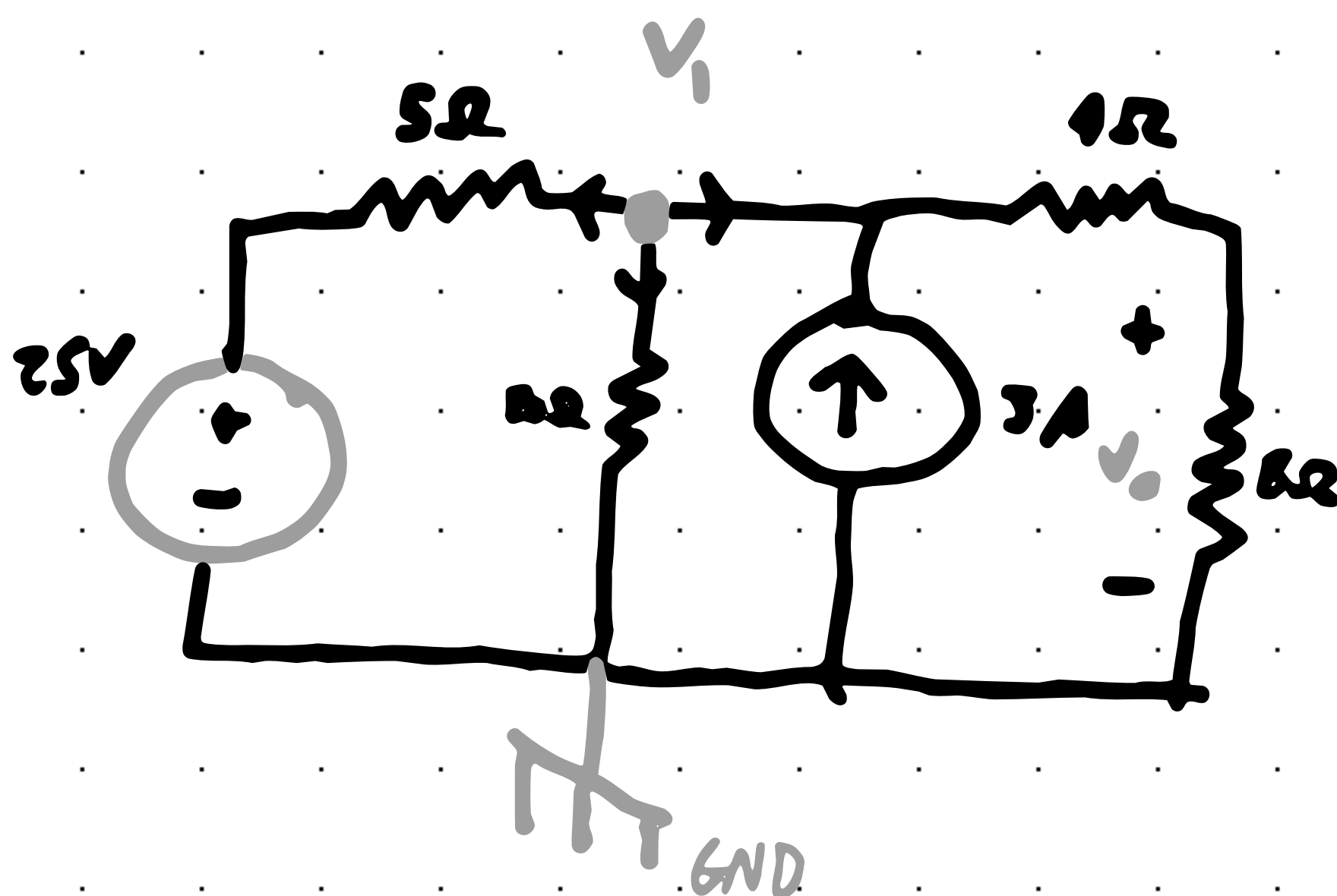
- Removing a Voltage Source requires a Short circuit to be swapped in.
- Removing a Current Source requires an open circuit to be swapped in.

Solution

Apply 25V, and
Remove 3A



Let's begin by Solving with Nodal Analysis



$$\sum I = 0$$

@ Node 1

$$\frac{V_1 - 25}{5} + \frac{V_1}{20} + \frac{V_1}{25} = 0$$

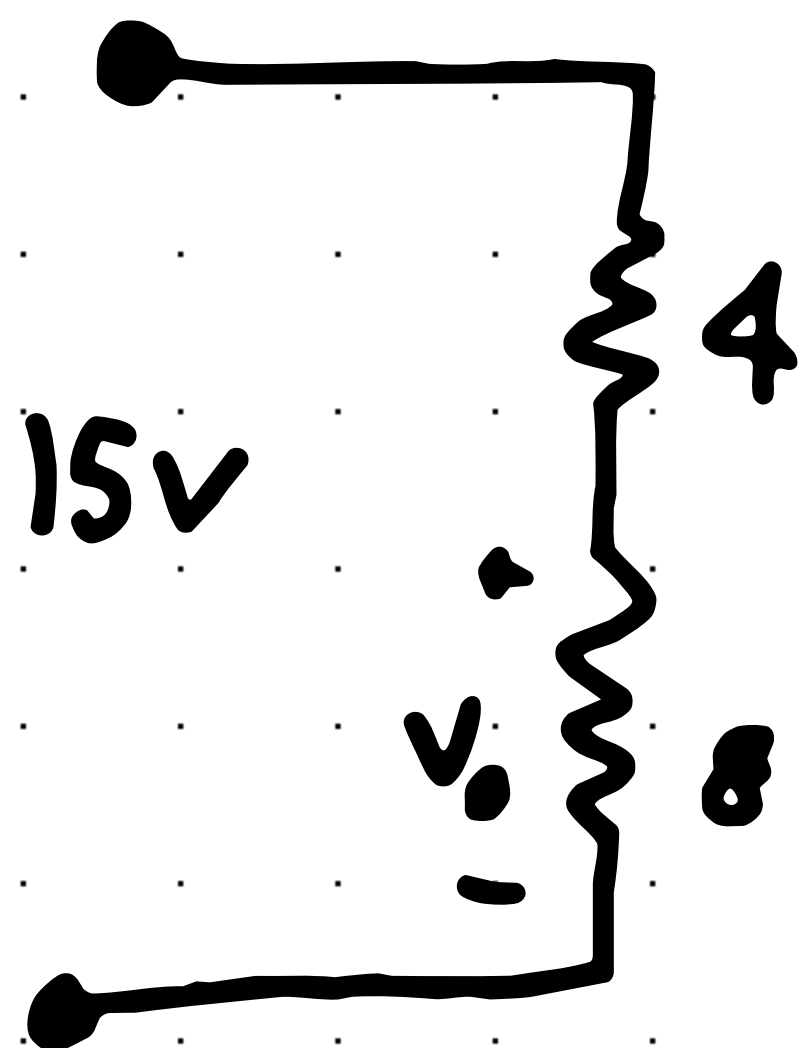
Factor, and

$$V_1 \left[\frac{1}{5} + \frac{1}{20} + \frac{1}{25} \right] = \frac{25}{3} = 5$$

move over $\frac{25}{3}$

$$V_1 = 5(3) = 15V$$

Now, Let's Solve it
Using Voltage divider



$$V_o = V_i \left(\frac{8}{4+8} \right) = 10V$$

Note For High-Schoolers 😊

You can also solve this problem using
a concept known as "Ohm's Law"

$$V = IR$$

(Volts) (Current) (Resistance)

This is a VERY Fundamental idea that
if you ever work electricity, you will 100%
deal with. Everything we did today builds
on this. It might be worth re-visiting
in the future!

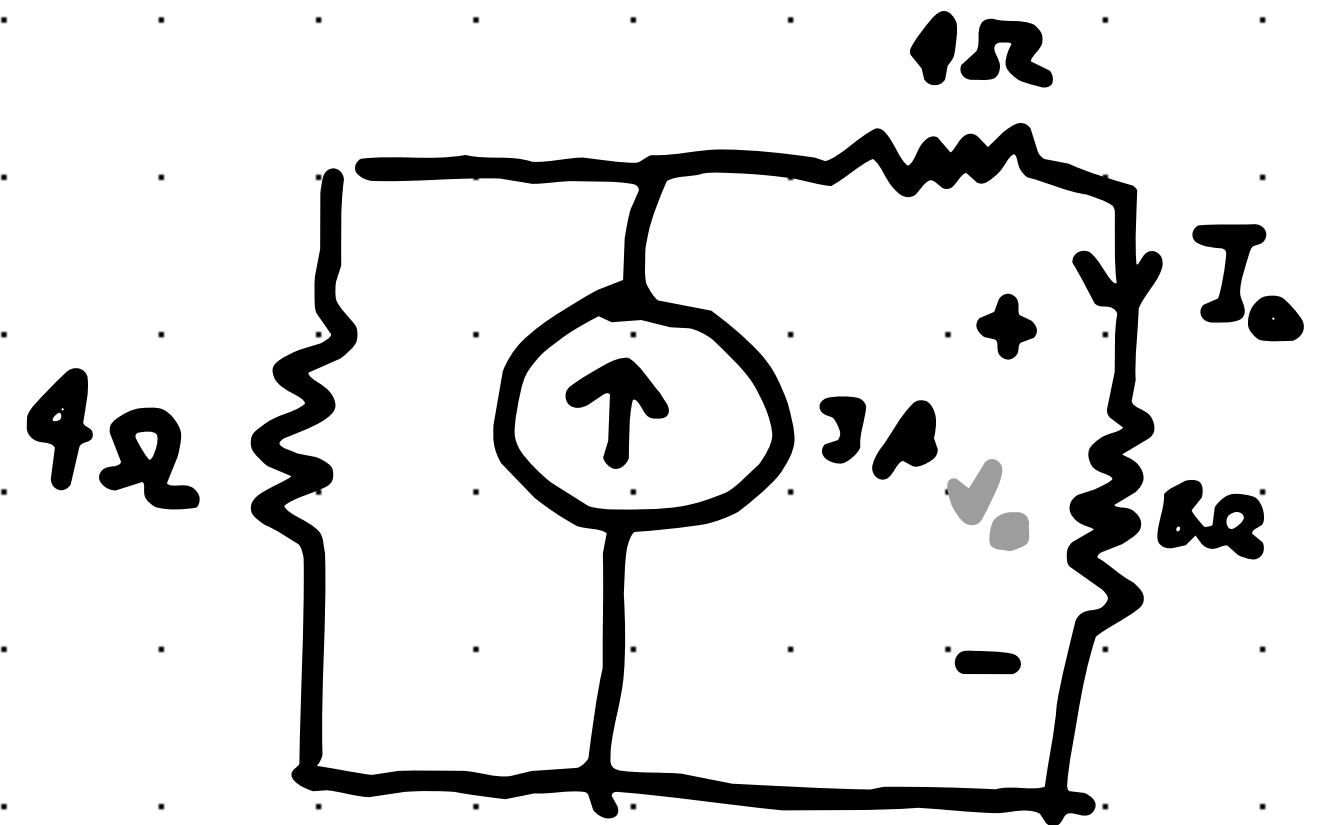
(You will see in PHYC 12)

Now, let's remove the voltage source instead!

OHM'S LAW!

$$5 // 20 = \frac{5(20)}{5+20} = 4 \Omega$$

(Parallel)



Using Current divider (Variation of Ohm's Law)

$$I_o = 3 \left(\frac{4}{4 + (4+8)} \right) = 0.75 A$$

So,

$$V_o'' = 8(0.75) = 6V$$

$$V_o = V_o' + V_o'' + 10 + 6 = 16V$$

Left Page

NOTE:

You Cannot Use these
Superposition Created " V_o' " and
" V_o'' " to Calculate Power.

$$P = \frac{V_o'^2}{R} = \frac{10^2}{8} = 12.5 \text{ W}$$
$$P'' = \frac{V_o''^2}{R} = \frac{6^2}{8} = 4.5 \text{ W}$$

$P = VI$ and
 $P = \frac{V^2}{R}$ are
non-linear!

$$P_{8\Omega} \neq P' + P''$$

ie..

$$\frac{V_o^2}{R} \neq \frac{(V_o')^2}{R} + \frac{(V_o'')^2}{R}$$
$$V_o^2 \neq V_o'^2 + V_o''^2$$

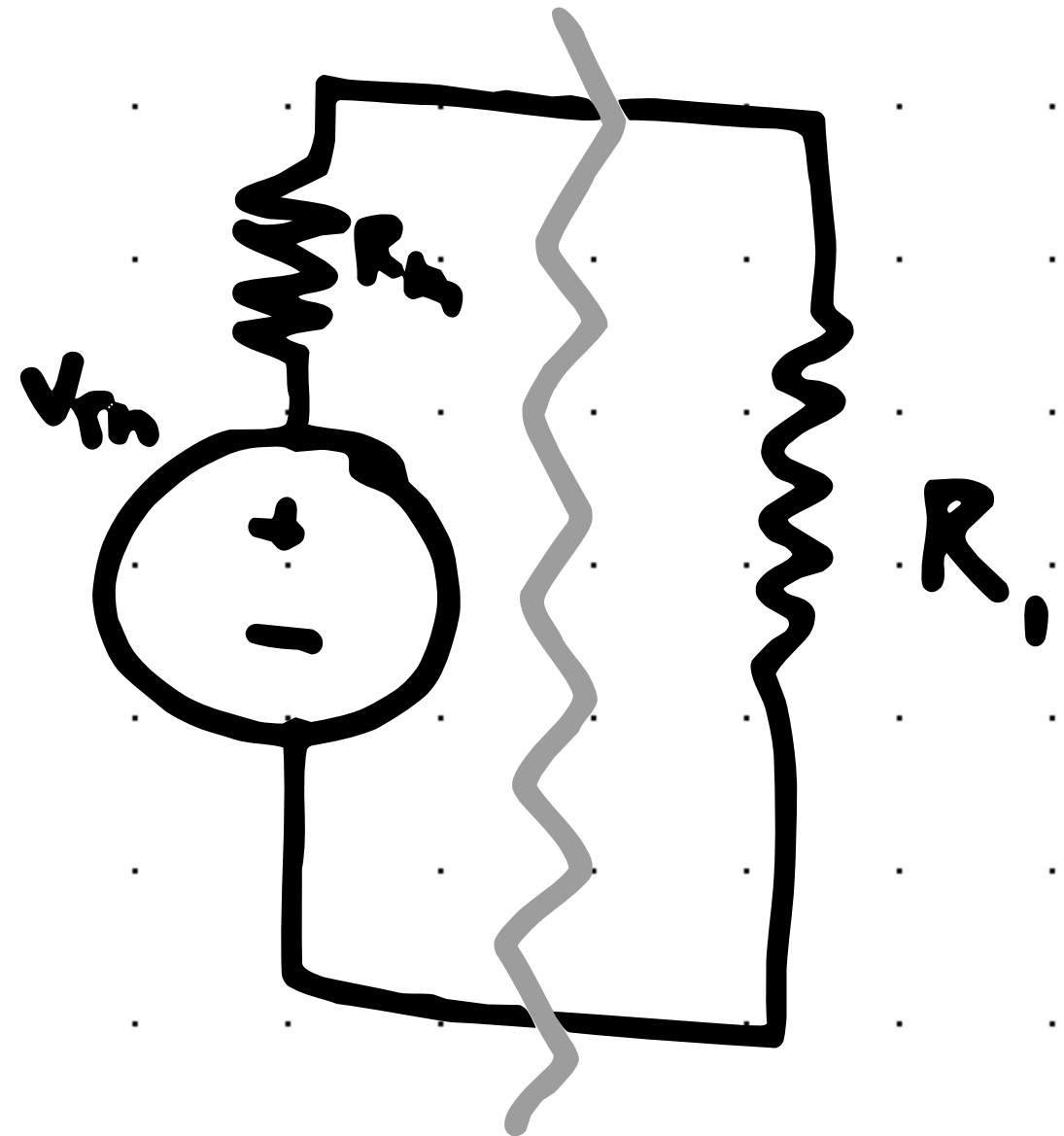
$$(V_o)^2 = (V_o' + V_o'')^2$$

5

Thevenin and Norton theorems:

Thevenin:

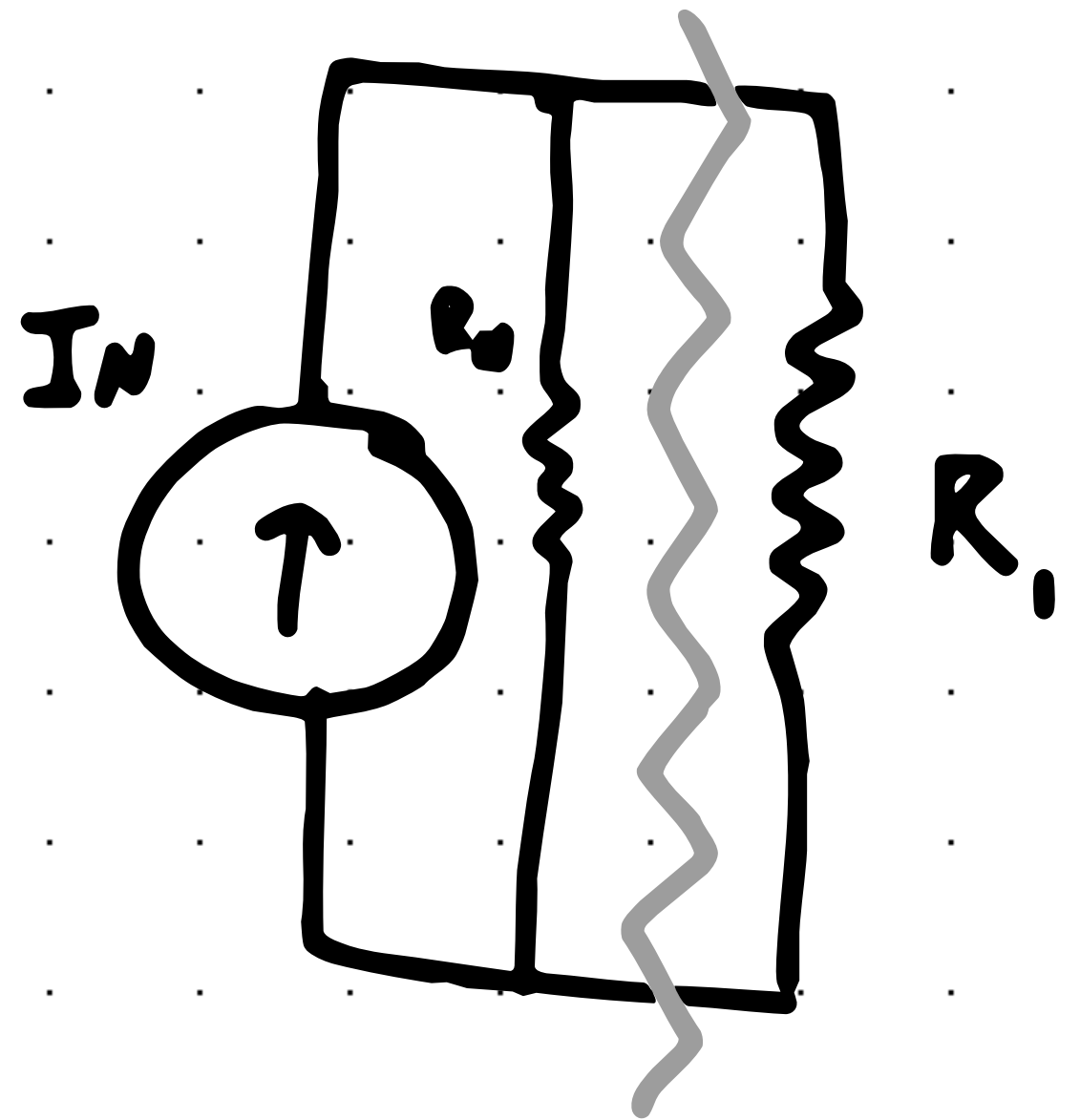
If you want to do analysis on R_L for any circuit, you can shrink the circuit down to an equivalent circuit like this.



Voltage Source
Thevenin Equivalent

Norton:

If you want to do analysis on R_L for any circuit, you can shrink the circuit down to an equivalent circuit like this.



Current Source
Norton Equivalent

How do we Calculate $V_{\text{Therminal}}$ and I_{Norton} ?

$V_{\text{Therminal}}$

- 1) Remove The Branch that you are looking to find V_{TH} across.
- 2) Find the voltage across the newly created open circuit.
- 3) $V_{\text{openCircuit}} = V_{\text{Therminal}}$

I_{Norton}

- 1) Remove the branch that you are looking to calculate I_{Norton} across.
- 2) Short the newly created hole
- 3) Solve for current across the short.

$$I_{\text{shortCircuit}} = I_{\text{Norton}}$$

To Calculate $R_{TH} = R_N$

①

$$R_{TH} = R_{Norton} = \frac{V_{Thermin}}{I_{Norton}}$$

* If you have $V_{Thermin}$ and I_{Norton}

②

Replace any independent voltage source by a short circuit and any independent current source by an open circuit

Then, use any voltage source (any value like 1, 10...) to inject a specific value in the circuit across the branch

Haven't Completed! Catch up from
Posted Notes: