MAE 3780/3783: Mechatronics
January 31, 2024

Logistics Updates

- This week in lab – **Lab 1**
  - Tinkercad prelab 15 minutes before lab session
  - Written prelab printed or shown on device at beginning of lab section
  - Set dial to 10A jack, make sure it's safe, and then move on to the 200mA jack

3. Measure the current through the LED.
   a. Move the red probe to the "mA" jack.
   b. Set the dial to 200mA DC (the "A" with straight and dashed lines next to it).

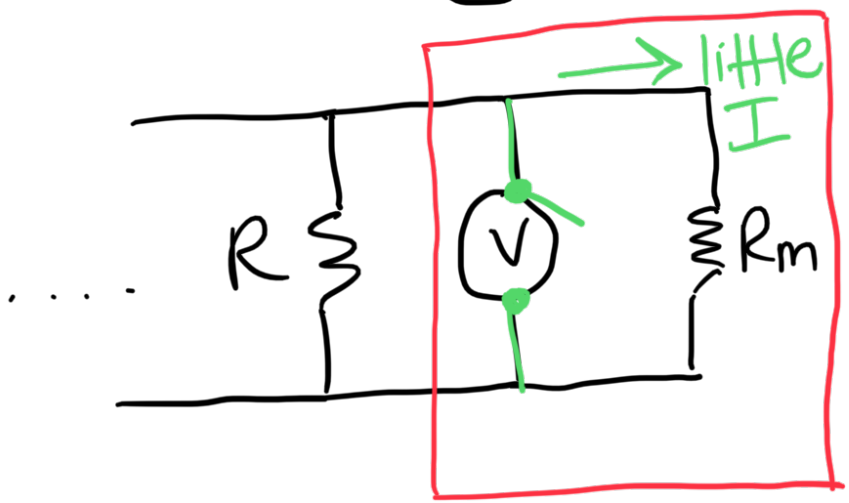
- HW 2 (resistors) was released at 10 am
  - Due **Friday, February 9, 11 pm**
- Reminder: Email formatting & contents

Measurement Devices

Voltmeter: connected in parallel
⇒ "should not" draw current

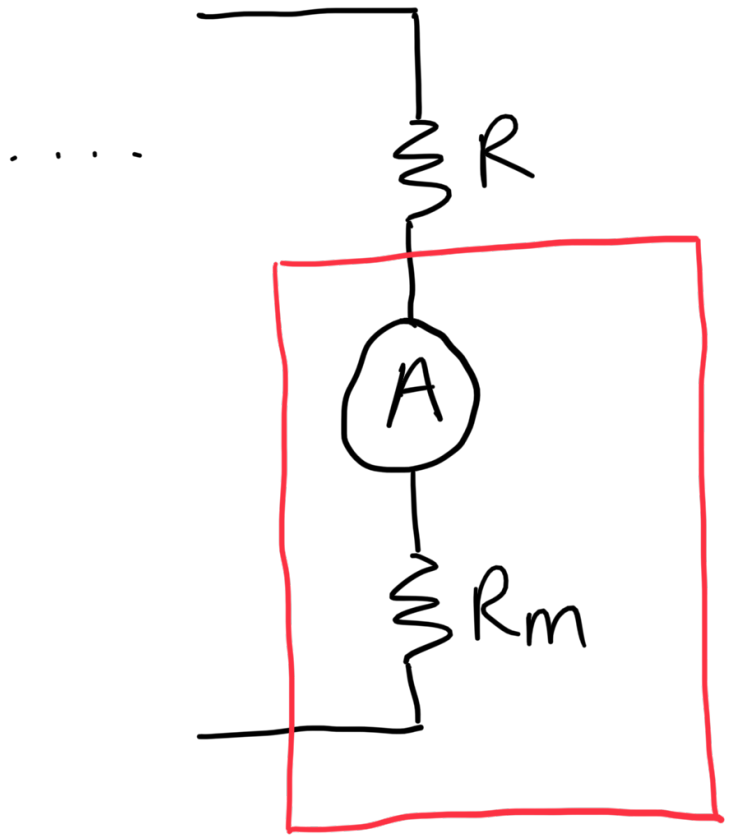
Ammeter: connected in series
⇒ "should not" have a voltage drop

practically,



voltmeter

want Rm to be large



ammeter

want Rm to be small

Circuit Analysis

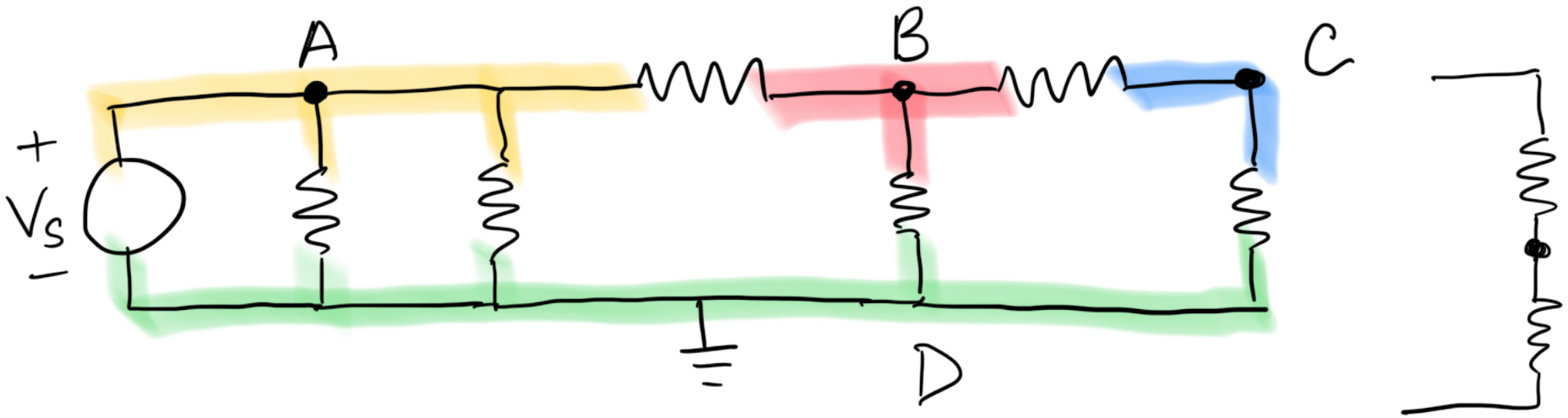
find I, V for all devices

- R_{eq} (KVL, KCL, Ohm's Law)
- Node analysis
- Mesh analysis

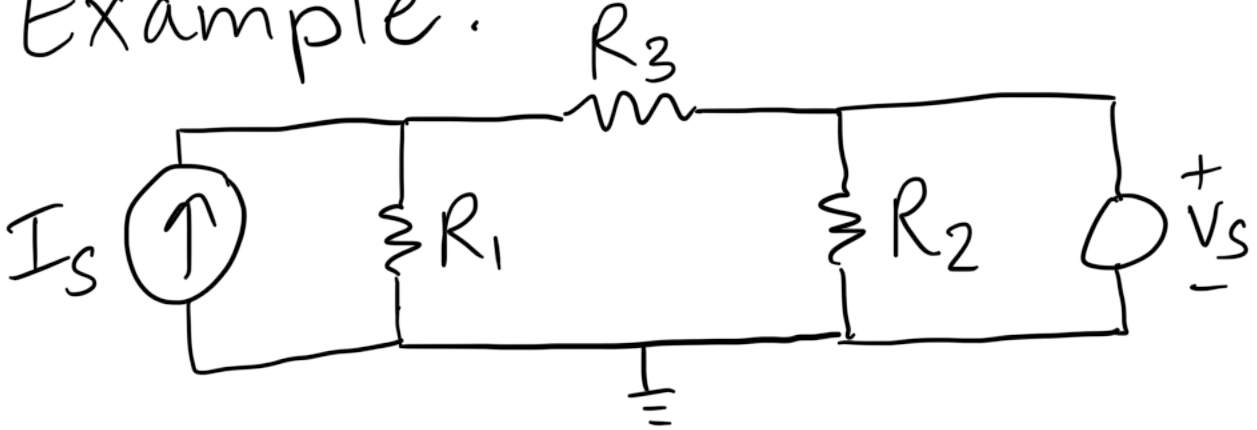
} systematic way of writing equations

$$Ax = b$$

A: known, x: unknown, b: known



Example:



$V_{R_3} = ?$

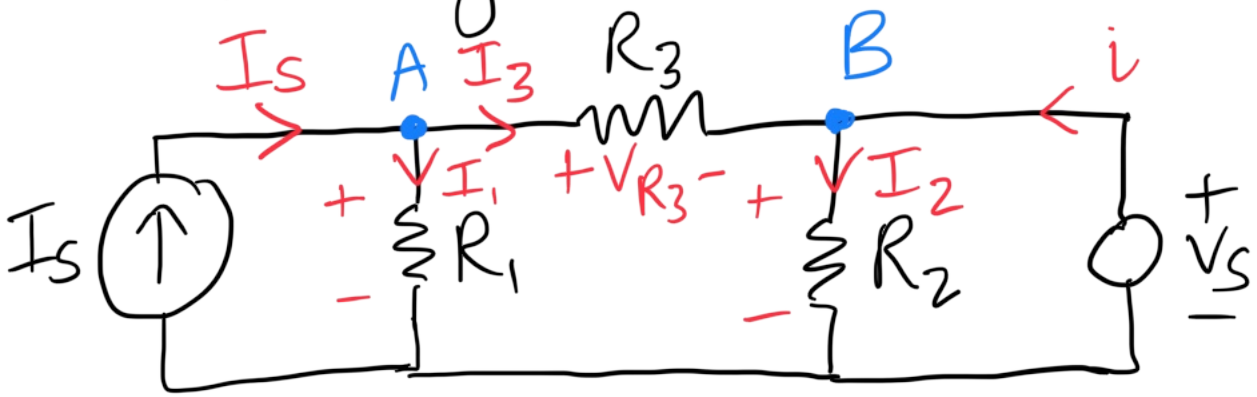
Node analysis:

unknowns: ① voltages at nodes
② currents at voltage sources

Known: ① sources

equations to use:

- KCL represented using voltages
- voltage sources



unknowns: V_A, V_B, i

KCL at nodes:

node A: $I_S = I_1 + I_3$

ohm's law: $I_S = \frac{1}{R_1} V_A + \frac{1}{R_3}(V_A - V_B)$

$\left(\frac{1}{R_1} + \frac{1}{R_3}\right) V_A - \frac{1}{R_3} V_B = I_S$ Known

node B: $I_3 + i = I_2$

ohm's law: $\frac{1}{R_3}(V_A - V_B) + i = \frac{1}{R_2} V_B$

$\frac{1}{R_3} V_A - \left(\frac{1}{R_3} + \frac{1}{R_2}\right) V_B + i = 0$ known

voltage source: $V_S = V_B$

together:

$$\begin{bmatrix} \frac{1}{R_1} + \frac{1}{R_3} & -\frac{1}{R_3} & 0 \\ \frac{1}{R_3} & -\left(\frac{1}{R_3} + \frac{1}{R_2}\right) & 1 \\ 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} V_A \\ V_B \\ i \end{bmatrix} = \begin{bmatrix} I_S \\ 0 \\ V_S \end{bmatrix}$$

A x b

originally incorrectly written in lecture; this is correct

$$Ax = b \implies x = A^{-1}b$$