Class 2: Circuit Analysis Techniques

Activity 2 – KCL, KVL, Series and Parallel Resistors

January 13th, 2022

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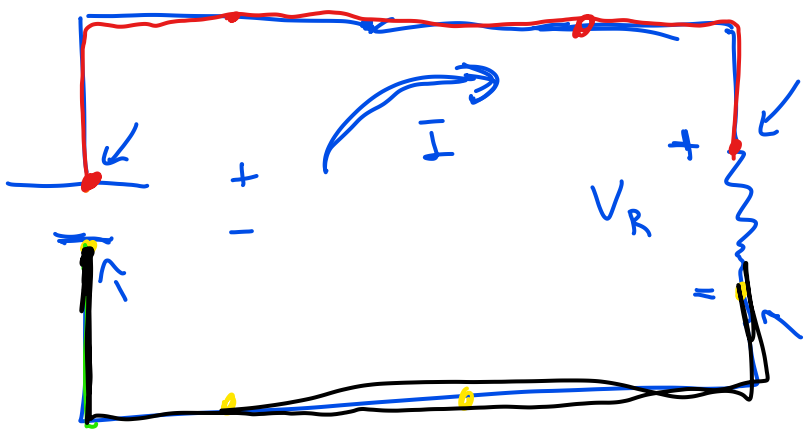
Intro to ECSE

Model of a Car Battery
Lights ON and Engine OFF



$V_R = V_{red} - V_{black} = 12\ V$

Constant DC Source

12 V

$V_{red} - V_{black}$ = 12 V

headlights

$R = 8\ \Omega$ (ohms)

$= 8\ V/A$

ohm's law: $\boxed{V_R = R\,I}$

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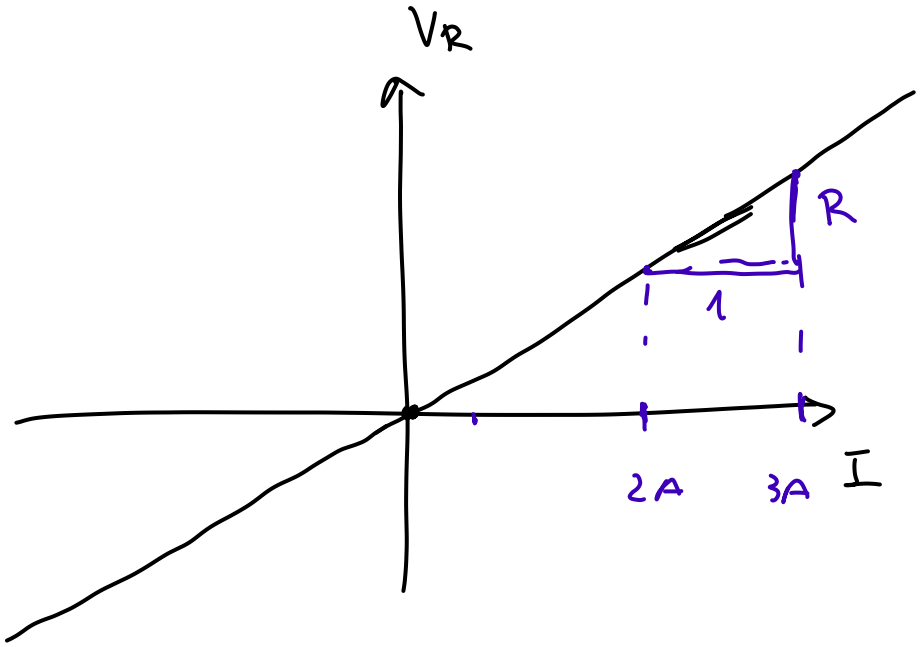
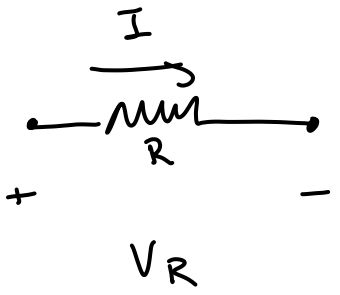
open switch: $I = 0 \Rightarrow V_R = R \cdot 0 = 0$

closed " : $I = \frac{V_R}{R} = \frac{12\ V}{8\ \Omega} = 1.5\ \frac{V}{V/A} = 1.5\ A$

Ohm's Law





$$V_R = R\,I$$

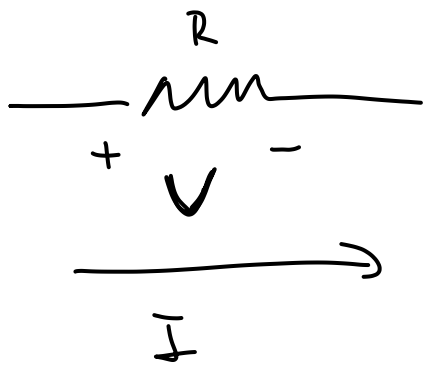
I-V characteristics

What is so cool about resistors?

* They are in every circuit
* Many sensors are based on resistors
  - Thermistor : temperature dependent resistance
  - Force sensitive resistors
*

What about power absorbed by resistors

- Resistors are passive linear elements
- They can only absorb power
- Power relationships:



$$V = RI$$

$$I = \frac{V}{R}$$

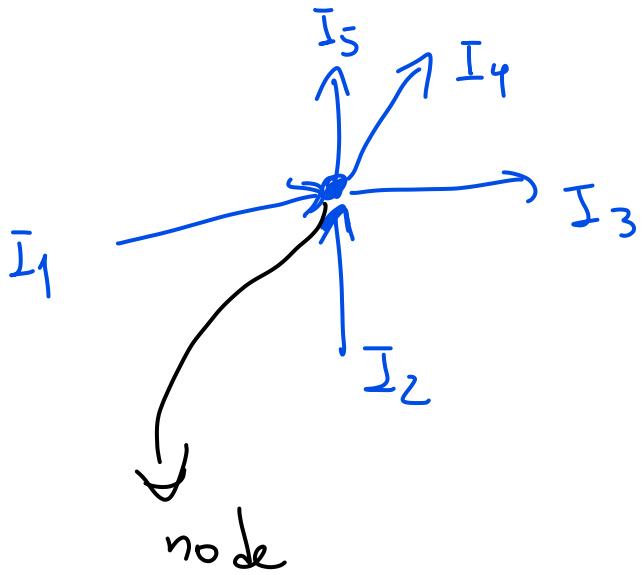
$$P = V \cdot I \quad \text{(watts)}$$

$$= RI \cdot I = R I^2$$

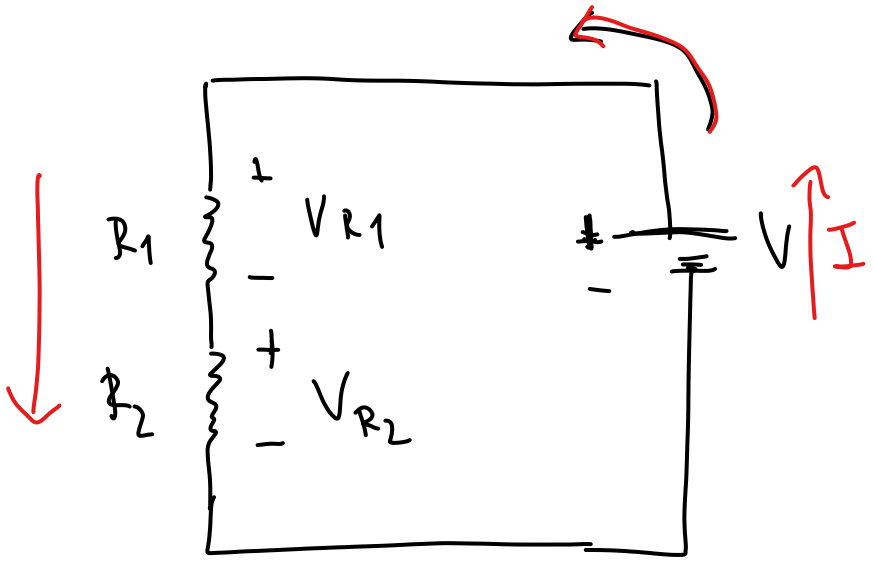
$$= V \frac{V}{R} = \frac{V^2}{R}$$

Kirchoff's Current Law (KCL)

$$I_1 + I_2 = I_3 + I_4 + I_5$$



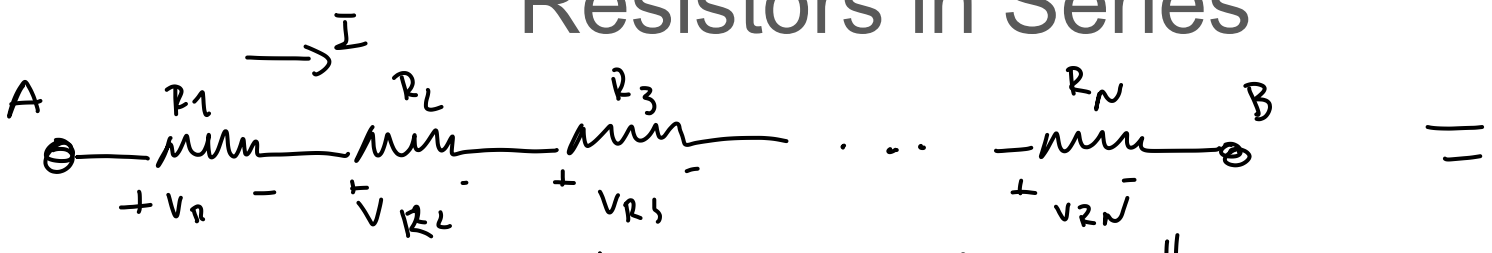
Kirchoff's Voltage Law (KVL)



$$V = V_{R1} + V_{R2}$$

$$V - V_{R1} - V_{R2} = 0$$

Resistors in Series



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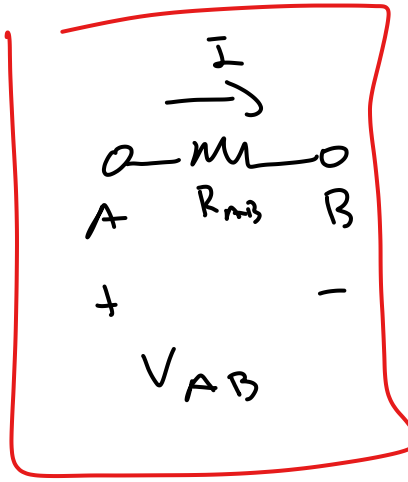


Current is the same for all resistors

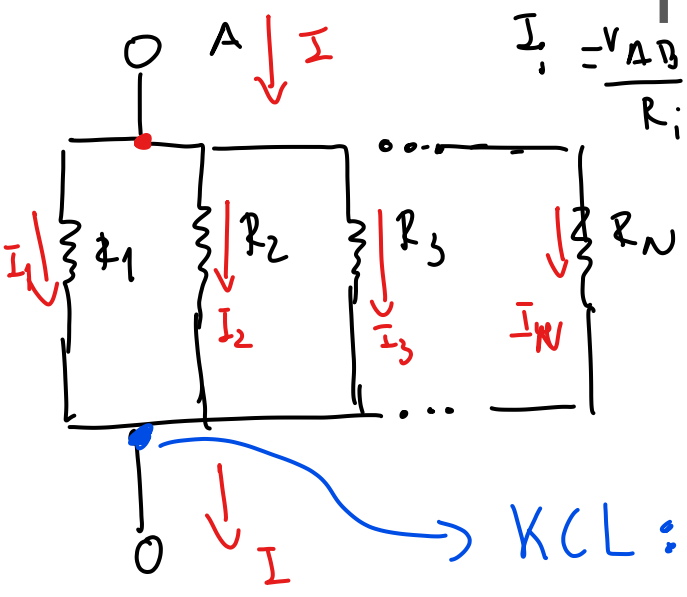
$$R_{AB} = \sum_{i=1}^{N} R_i = R_1 + R_2 + R_3 + \dots + R_N$$

Ohm's law: $V_{AB} = R_{AB} I$

KVL : $V_{AB} = V_{R1} + V_{R2} + \dots + V_{RN}$

$R_{AB} I = R_1 I + R_2 I + \dots + R_N I$

Resistors in Parallel



$I_i = \frac{V_{AB}}{R_i}$

They have the same voltage

$$R_{AB} = \frac{1}{\left(\sum_{i=1}^{N} 1/R_i\right)}$$

KCL: $I_1 + I_2 + \cdots I_N = I$

$$\frac{V_{AB}}{\sum_{i=1}^{N} V_{AB}/R_i}$$

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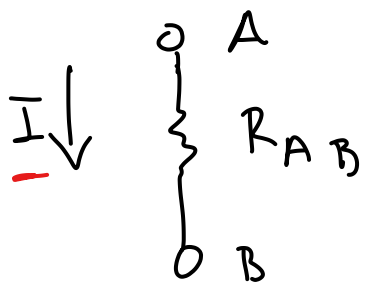
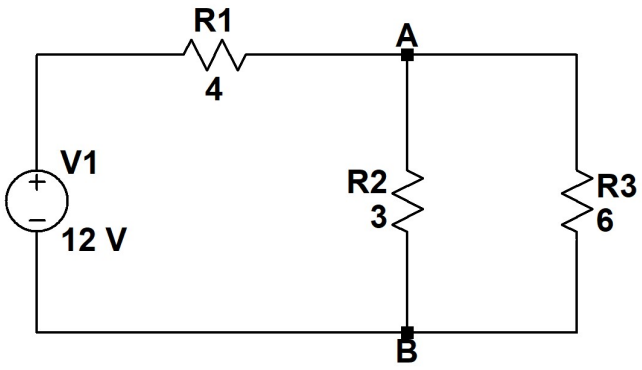


ohm's: $R_{AB} = \frac{V_{AB}}{I} = \frac{V_{AB}}{\sum_{i=1}^{N} |I_i|}$

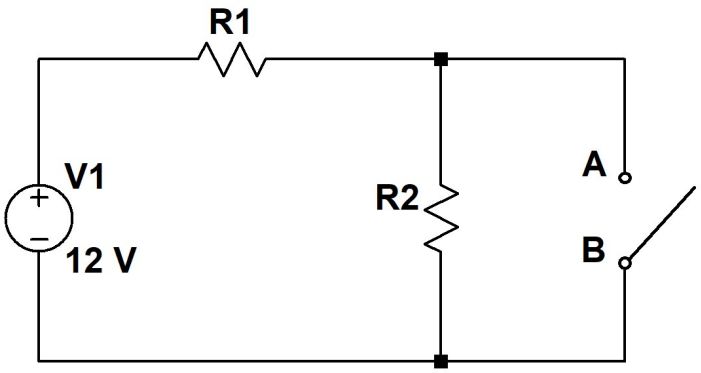
Example 1: Circuit Analysis

Find current through R2 and R3



Example 2: Circuit Analysis

Find current through R1



Activity 2: KCL, KVL, Series and Parallel Resistors

- Go to the class website
- Look under class 2
- Find activity 2
- Do the activity
  - Individual submission for activity 2
  - Encouraged to discuss with others in the class on WebEx Teams
- Answer the activity using template (attached class 2)
- When complete – upload to Gradescope
  - Due ~~Thursday, February 4th~~ at 11:59 pm Monday 24th
  - Use guides to learn how to upload documents