EECS 70A: Network Analysis

Lecture 2

Announcements

- HW to be posted online- due Wed week 2 in disc.
- Quiz to be online eee- due Mon midnt. week 2
- Office hours posted online
- Lecture notes will be posted online
  - Skeleton before lecture
  - With annotation after lecture
- Please ask questions in lecture!
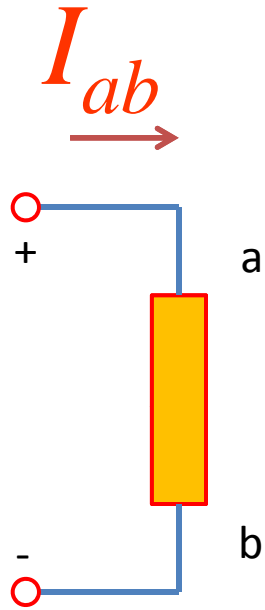- Things will speed up…

Review & agenda

Last lecture:
- Current
- Voltage
- Power

Today:
- Examples
  - Power (sink/source)
  - Current (postive/negative)
  - Dependent sources
- Resistors
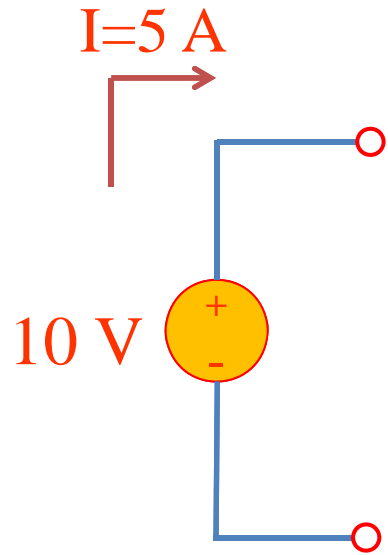 - Series
  - Parallel

Power: Source vs. sink

$$I_{ab}$$

$$P = I_{ab} \; x \; V_{ab}$$

+

a

-

b

P > 0

$\Rightarrow$ "sink": power delivered to element
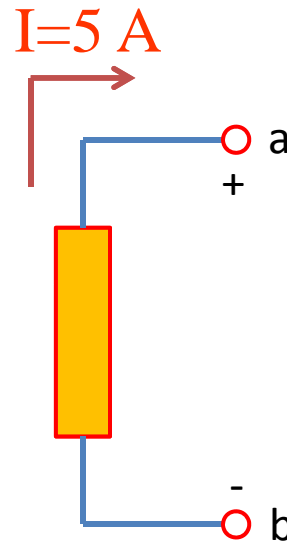
P < 0

$\Rightarrow$ "source": power supplied by element

"source"
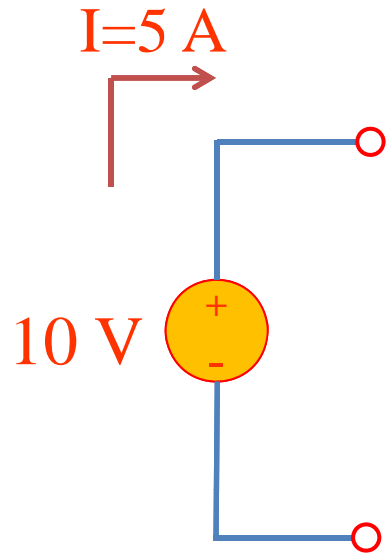
I=5 A

10 V ⊕ $+$ $-$

"source"

I=5 A

10 V (+ / -)

Draw or think of as:

I=5 A

a

+

-

b

$V_{ab} = 10$ V

$I_{ab} = -5$ A

Same as:
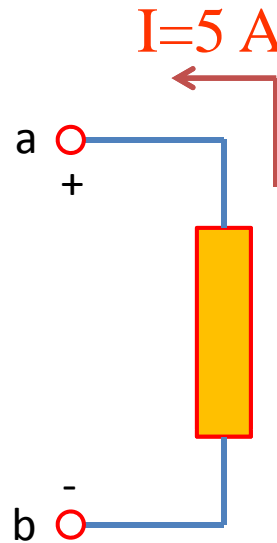
$P = I_{ab} \; x \; V_{ab}$

$-(-5 \text{ A}) \; x \; (10 \text{ V})$

$= -50$ W

I=5 A

a

+

-

b

$V_{ab} = 10$ V

$I_{ab} = -5$ A

Practice problems

Find the power absorbed or supplied by the element (instructor).

$I=5\text{ A}$

a

$+$

$V_{ab} = -\ 3\text{ V}$

-

b

Find the power absorbed or supplied by the element (instructor).

$I=10\text{ A}$

a

$+$

$V_{ab} = +\ 5\text{ V}$

-

b

Practice problems

Find the power absorbed or supplied by the element (student).

$I=10$ A

a $\circ$

$+$

$V_{ab} = + 3$ V

$-$

b $\circ$

Find the power absorbed or supplied by the element (student).

$I=3$ A

a $\circ$

$+$

$V_{ab} = - 2$ V

$-$

b $\circ$
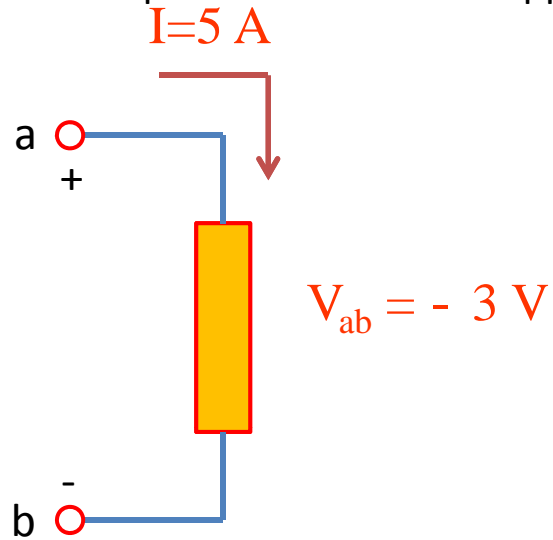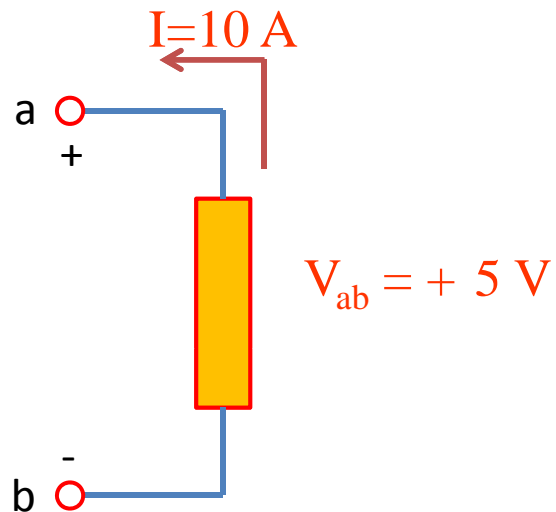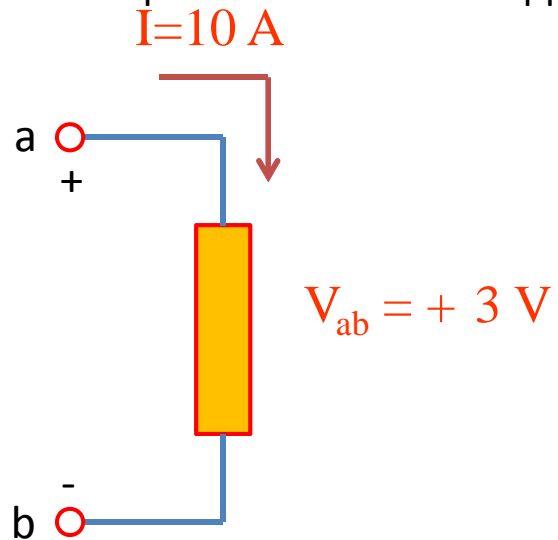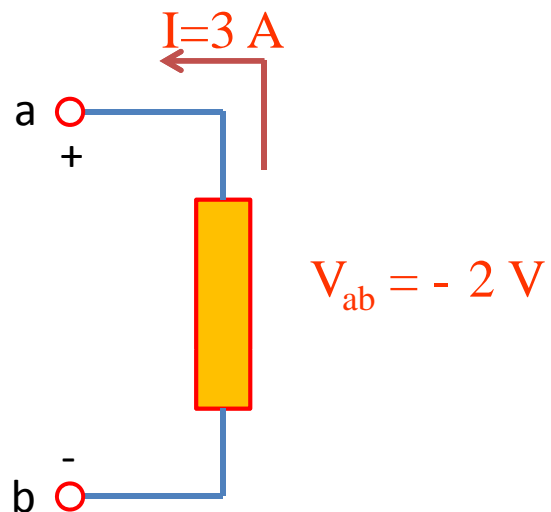
Example problem: Current (positive/negative)

Find the i_2, i_3 (instructor).

$i_1 = +2A$ i_3 i_2
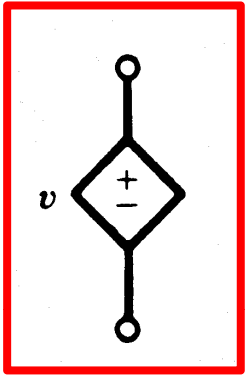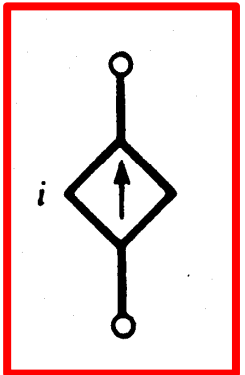
5 A

Recall:

i_1 i_2

i_3
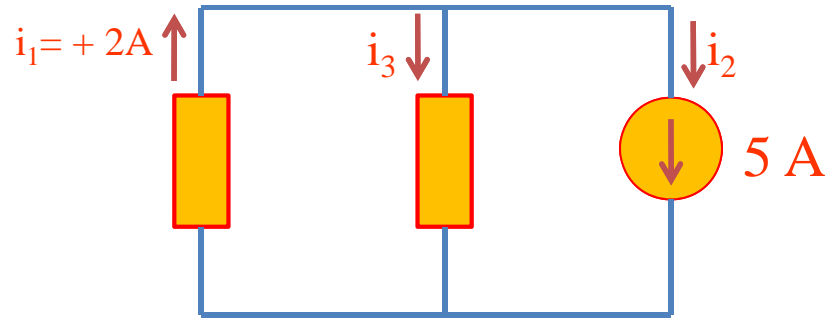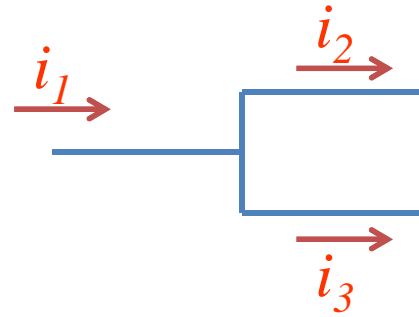
$$i_1 = i_2 + i_3$$

Like water in a river...
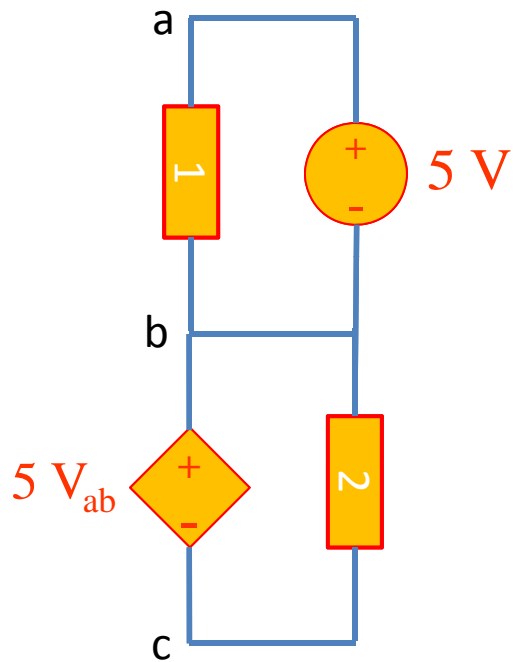
Dependent sources

VCVS: Voltage controlled voltage source
CCVS: Current controlled voltage source

VCCS: Voltage controlled current source
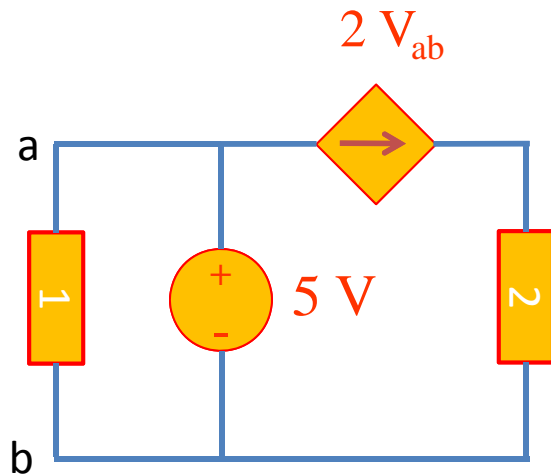**CCCS: Current controlled current source**

Voltage controlled voltage source (VCVS)
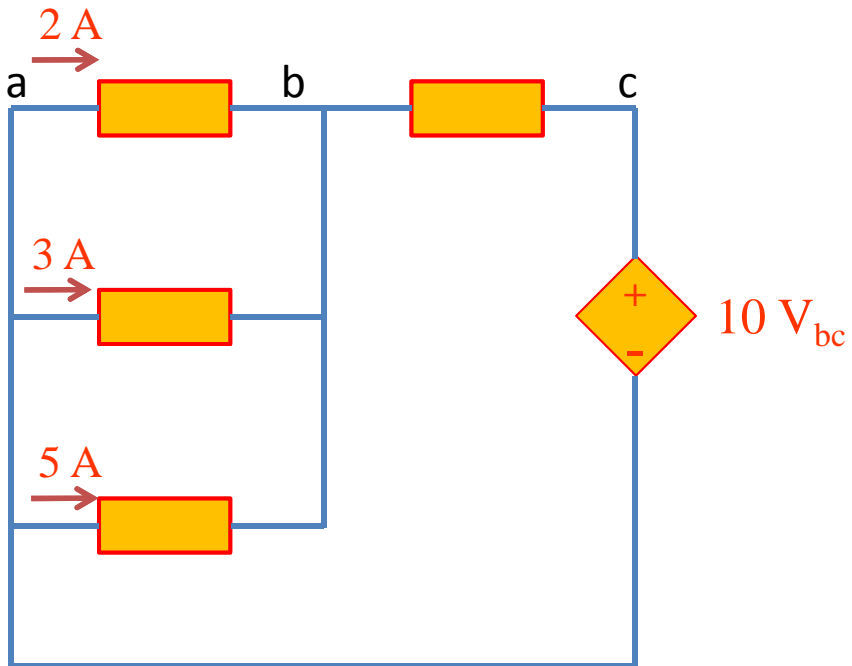
Find the voltage drop across element 2 (instructor).

Voltage controlled current source (VCCS)
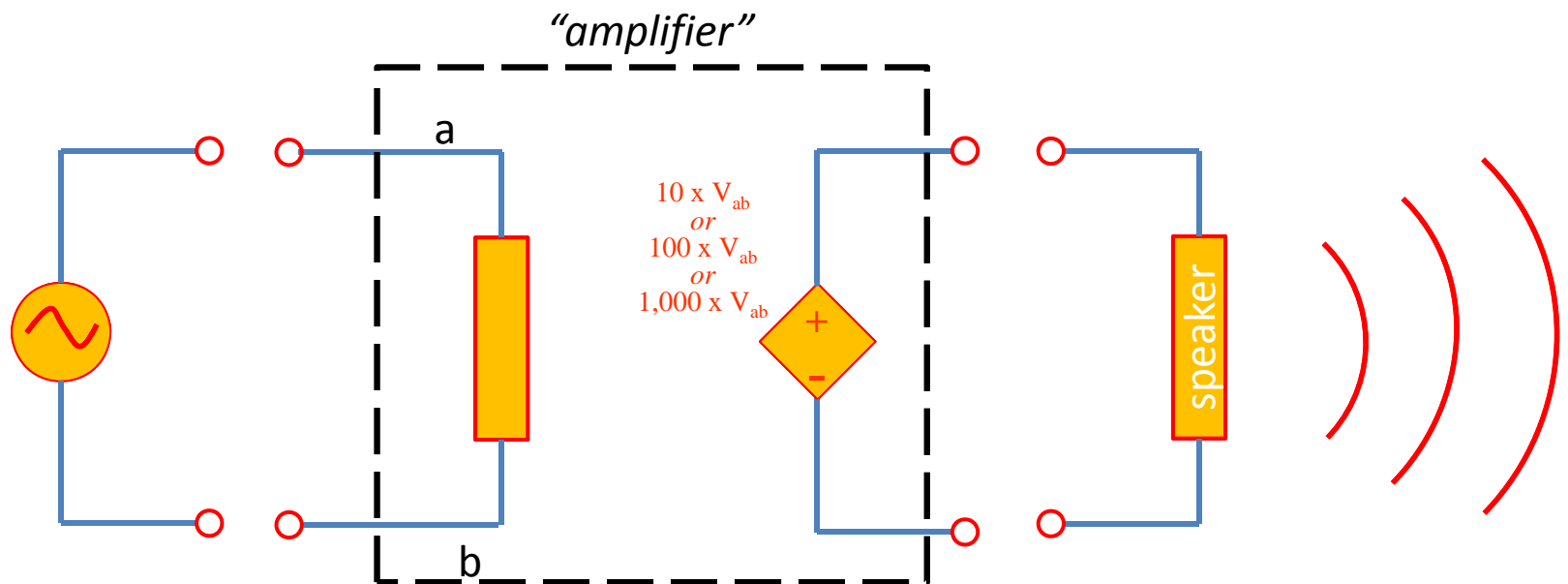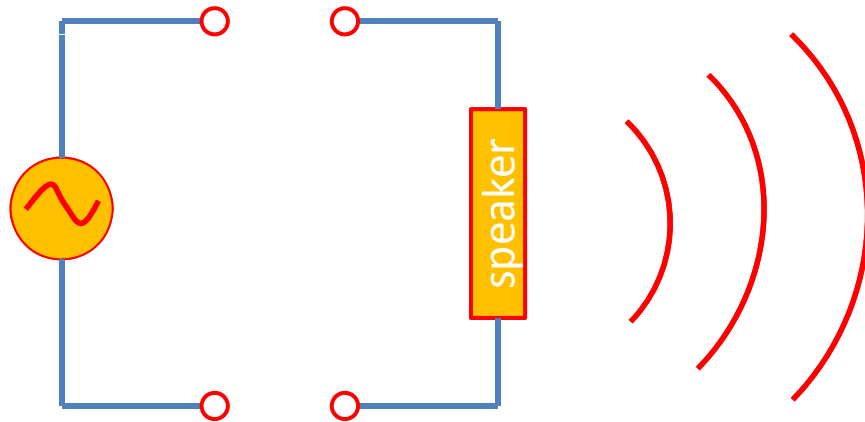
Find the current through element 2 (student).

$$2 \, V_{ab}$$

a

1

$+$
$-$ 5 V

2

b

Example problem.

Find the V_{bc} (instructor).

Practical example (demo).

"amplifier"

10 x V_{ab}
or
100 x V_{ab}
or
1,000 x V_{ab}

a

b

speaker

MKSA units-cheat sheet

Quantity	Name	Symbol	Expression in terms of other units	Expression in terms of MKSA base units
Frequency	Hertz	Hz		s^{-1}
Force	Newton	N		$m\text{-}kg/s^2$
Pressure	Pascal	Pa	N/m^2	$kg/m\text{-}s^2$
Energy	Joule	J	$N\text{-}m$	$kg\text{-}m^2/s^2$
Power	Watt	W	J/s	$kg\text{-}m^2/s^3$
Charge	Coulomb	C		$A\text{-}s$
Voltage	Volt	V	W/A	$kg\text{-}m^2/A\text{-}s^3$
Capacitance	Farad	F	C/V	$A^2\text{-}s^4/kg\text{-}m^2$
Resistance	Ohm	Ω	V/A	$kg\text{-}m^2/A^2\text{-}s^3$
Conductance	Siemens	S	A/V	$A^2\text{-}s^3/kg\text{-}m^2$
Inductance	Henry	H		$kg\text{-}m^2/A^2\text{-}s^2$

Questions?

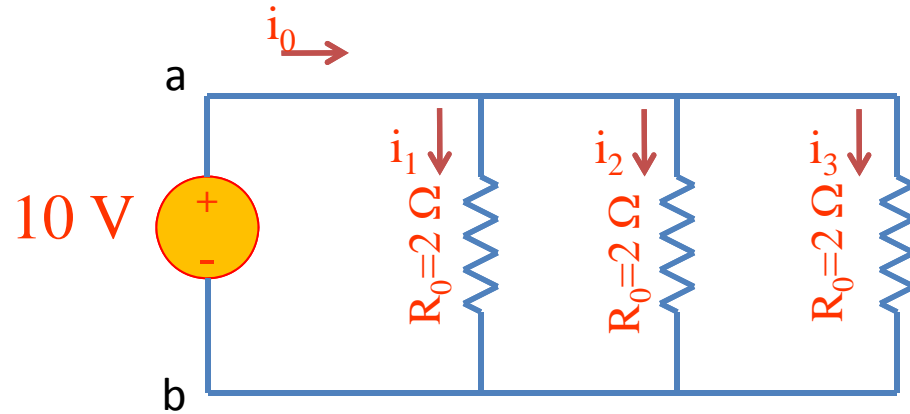# Resistors

I_{ab}

a ○

+

R

-

b ○
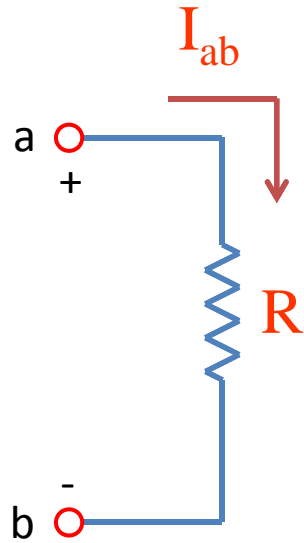
$$V_{ab} = I_{ab} \times R$$

Resistance units: Ohms [Ω]

Example circuit:
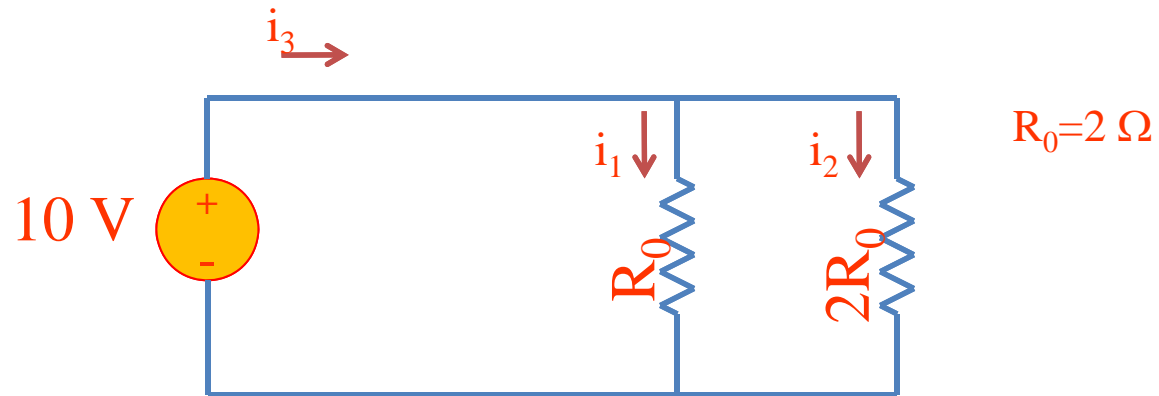(Voltage source in series with resistor.)

Example problem: Resistors in parallel.

Solve for all the currents and voltages in this circuit. (instructor).

Example problem: Resistors in parallel.

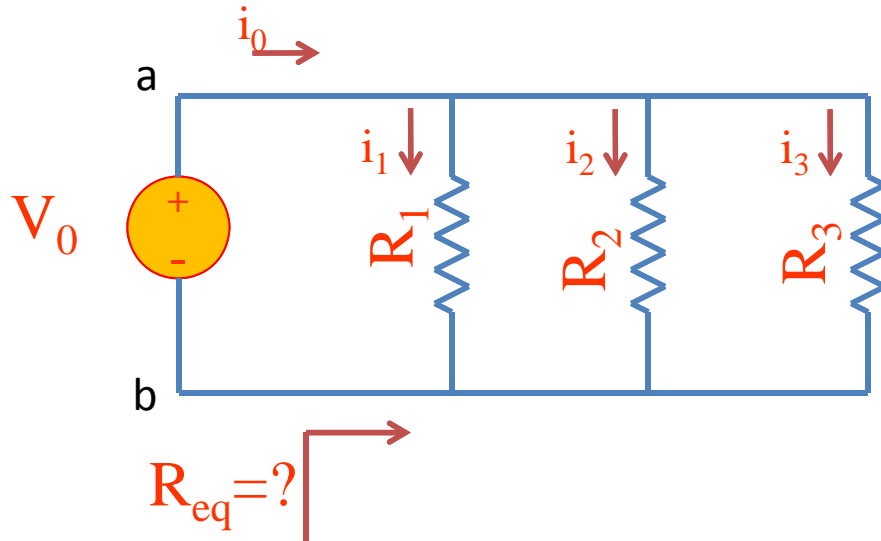Solve for all the currents and voltages in this circuit. (students).

i_3

$10\,V$

$+$
$-$

i_1

i_2

R_0

$2R_0$

$R_0 = 2\,\Omega$

a) Find i_1

b) Find i_2

c) Find i_3

d) Find R_{eq}

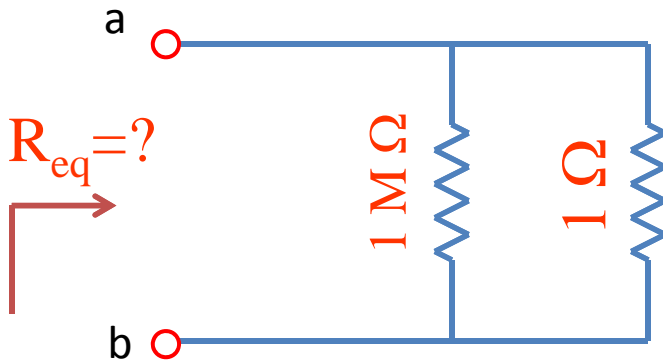# Generalize: N resistors in parallel.

Solve for R_{eq}. (instructor).

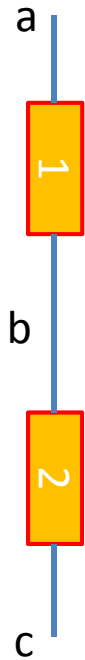# Example problem:

Solve for R_{eq}. (sudents).

$R_{eq}=?$

a

b

4 Ω   2 Ω   4 Ω
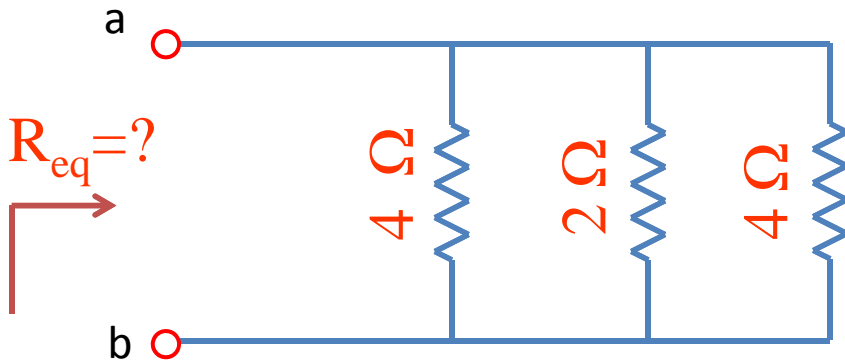
Important practical example:

Solve for R_{eq}. (instructor).

$R_{eq}=?$

a ○

1 MΩ   1 Ω

b ○

Questions?
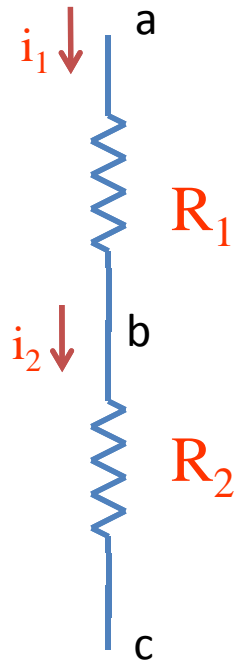
Voltage addition in circuits

a

b

c

$$V_{ab} \equiv \int_a^b Edx$$

$$V_{bc} \equiv \int_b^c Edx$$

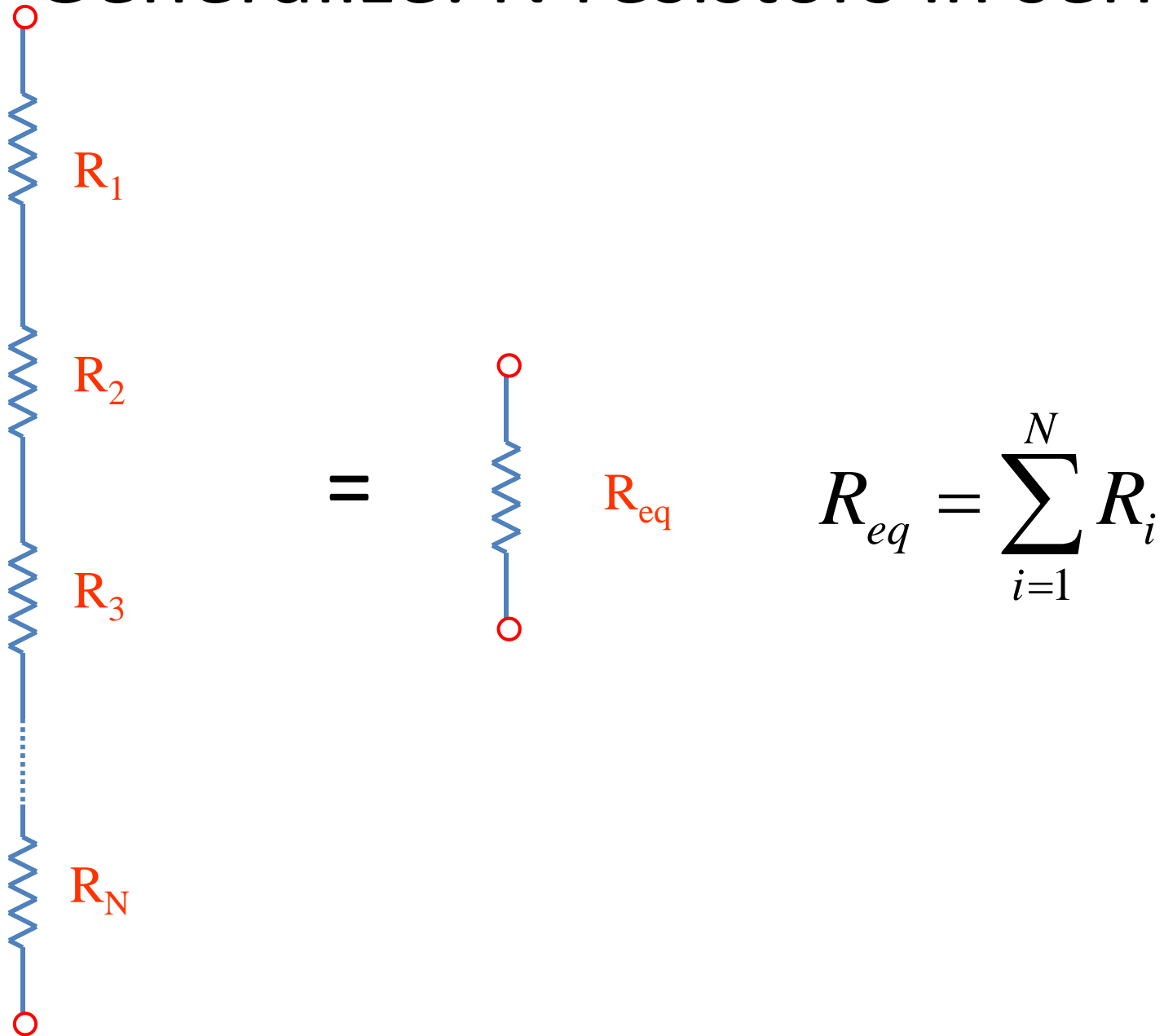$$\Rightarrow V_{ac} \equiv \int_a^c Edx = \int_a^b Edx + \int_b^c Edx = V_{ab} + V_{bc}$$
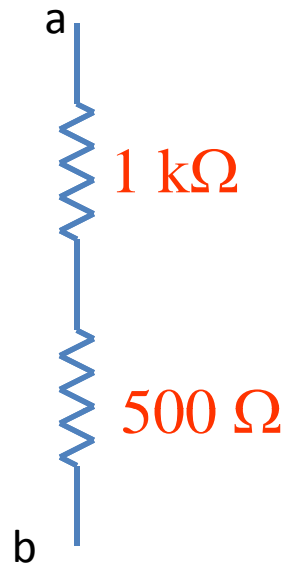
$$V_{ac} = V_{ab} + V_{bc}$$

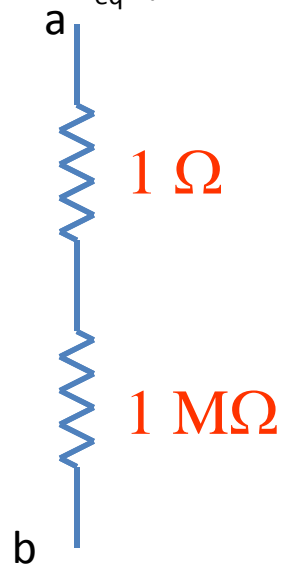# 2 resistors in series

Generalize: N resistors in series

$$R_{eq} = \sum_{i=1}^{N} R_i$$

Example problems

Solve for R_{eq}. (instructor).

a

1 kΩ

500 Ω

b

Solve for R_{eq}. (students).

a

1 Ω

1 MΩ
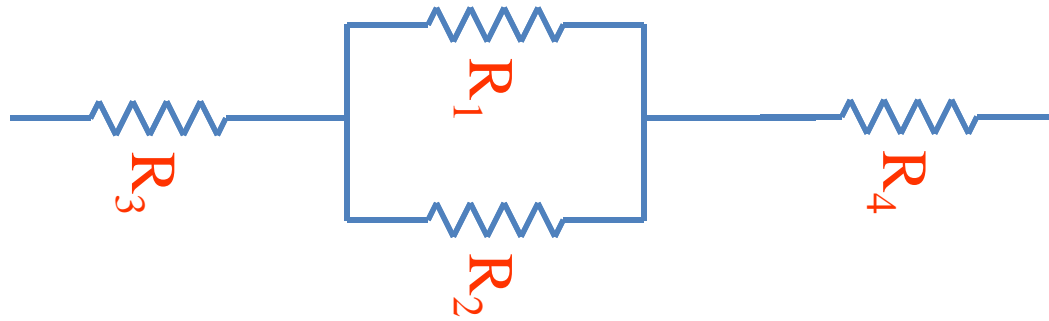
b

Questions?

Example problems

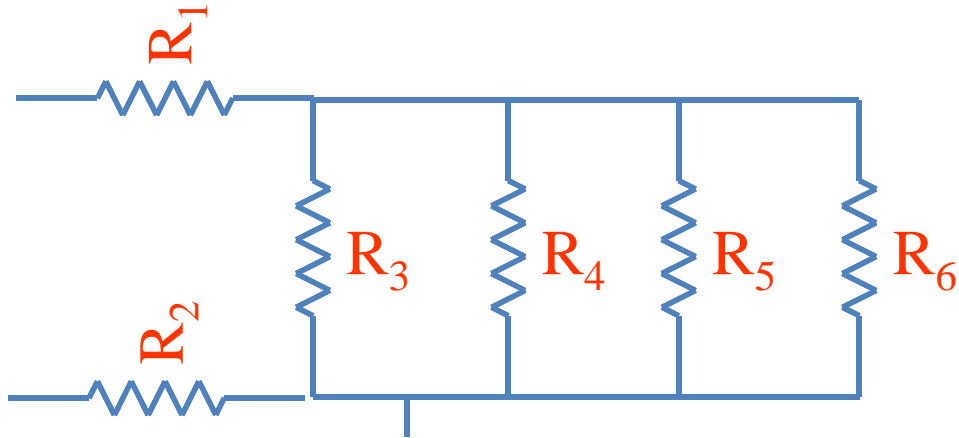Solve for R_{eq}. (instructor).
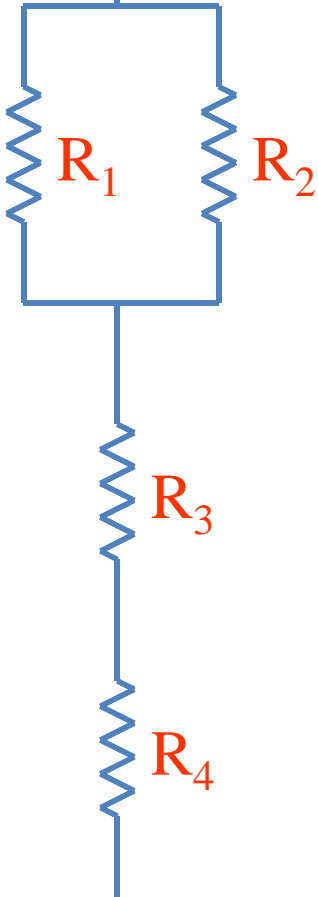
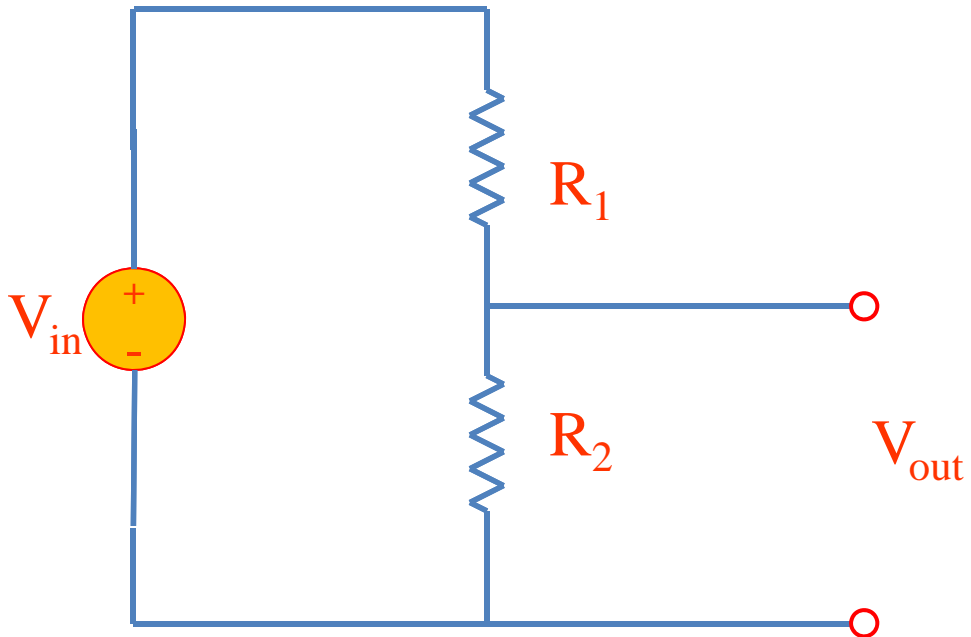# Example problems

Solve for R_{eq}. (students).

Example problems

Solve for R_{eq}. (instructor).

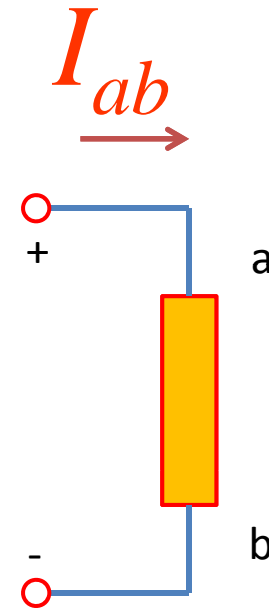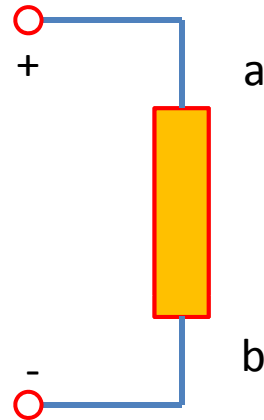# Example problems
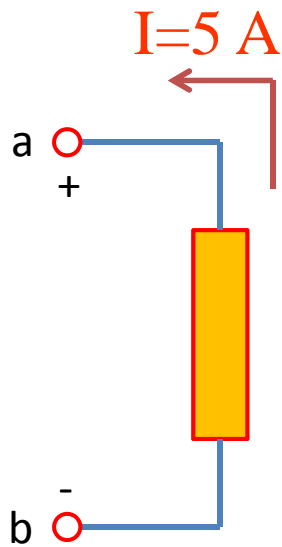
Voltage divider

$$V_{out} = \frac{R_1}{R_1 + R_2} V_{in}$$

Why important?
Concept of source/load. (Thevenin…)

Source/load concept

Symbol library

Symbol library