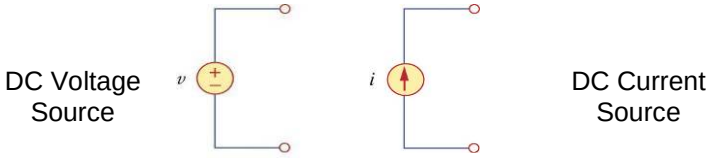
EE301 – Lesson 9
Reading: Sections 8.1-8.5

CURRENT SOURCES / SOURCE CONVERSION

Learning Objectives

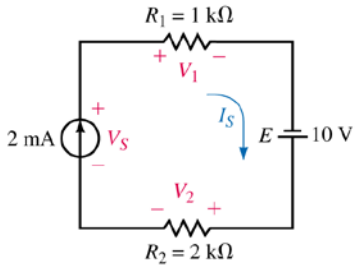
a. Analyze a circuit consisting of a current source, voltage source and resistors.
b. Convert a current source and a resister into an equivalent circuit consisting of a voltage source and a resistor.
c. Evaluate a circuit that contains several current sources in parallel.

Ideal sources An ideal source is an active element that provides a specified voltage or current that is completely independent of other circuit elements.



Constant Current Sources The voltage across the current source (V_S) is *dependent* on how other components are connected to it. Additionally, the current source voltage polarity does not have to follow the current source's arrow!

Example. Determine V_S in the circuit shown below.

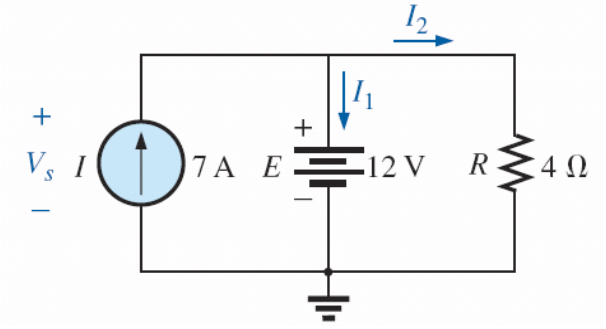


Solution:

Example. Determine V_S in the circuit shown above, but with R_2 replaced by a $6\,k\Omega$ resistor.

Solution:

Example. Determine I_1 and I_2 in the circuit shown below.

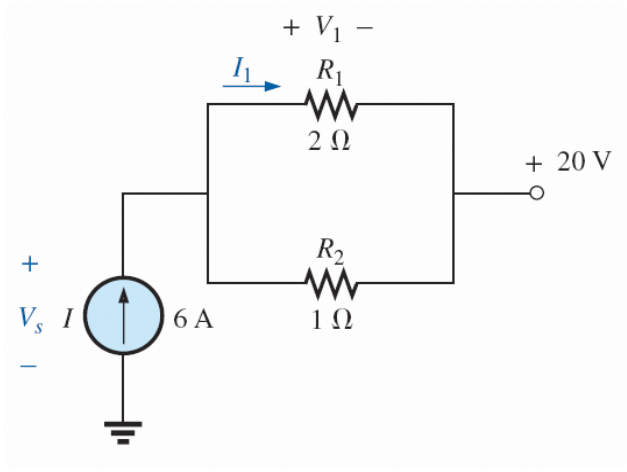


Solution:

Figure taken from Boylestad, *Introductory Circuit Analysis*, 12th ed., Prentice Hall, 2010

EE301 – Lesson 9
Reading: Sections 8.1-8.5

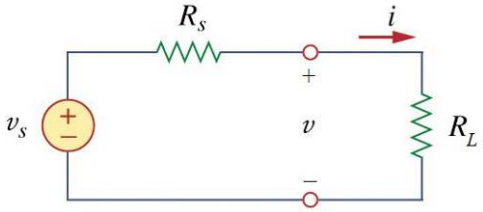
Example. Determine I_1 and V_S in the circuit shown below.



Solution:

Figure taken from Boylestad, *Introductory Circuit Analysis*, 12th ed., Prentice Hall, 2010

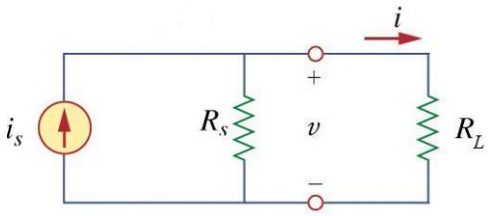
Practical voltage sources A real or practical source supplies its rated voltage when its terminals are not connected to a load (open-circuited) but its voltage drops off as the current it supplies increases.



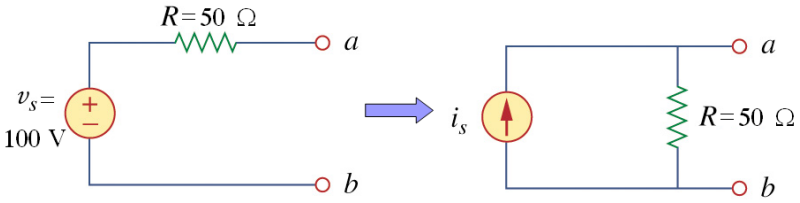
We can model a practical voltage source using an ideal source V_s in series with an internal resistance R_s.

Practical current source A practical current source supplies its rated current when its terminals are short-circuited but its current drops off as the load resistance increases.

We can model a practical current source using an ideal current source in parallel with an internal resistance R_s.



Source transformation: Voltage Source to Current Source We can, for the purposes of circuit analysis, replace a voltage source v_s in series with a resistor R by a current source i_s in parallel with the same resistor R.

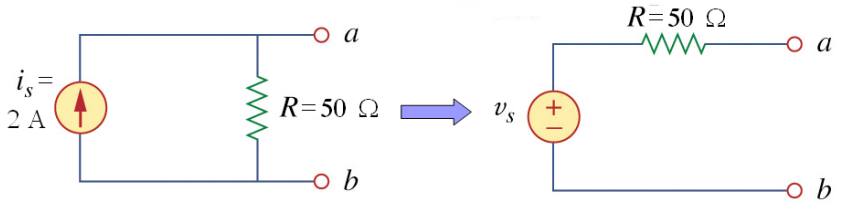


Question: How do you calculate the new current source value?

Answer: $i_S = \dfrac{v_S}{R} = \dfrac{100}{50} = 2$ A.

EE301 – Lesson 9
Reading: Sections 8.1-8.5

Source transformation: Current Source to Voltage Source We can replace a current source i_s in parallel with a resistor R by a voltage source v_s in series with the **SAME** resistor R.



Question: How do you calculate the new voltage source value?

Answer: $v_s = i_s R = (2A)(50\Omega) = 100\,\text{V}$.

Example. Determine the current I_2 in the circuit shown below.

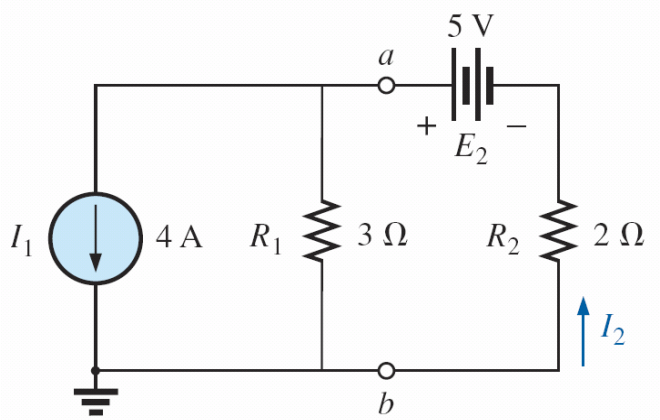


Figure taken from Boylestad, *Introductory Circuit Analysis*, 12th ed., Prentice Hall, 2010

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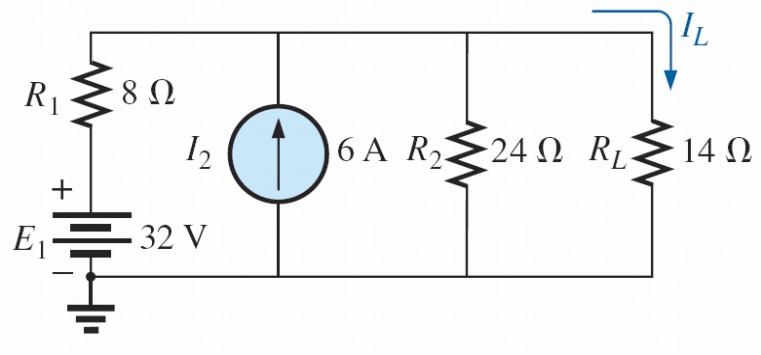
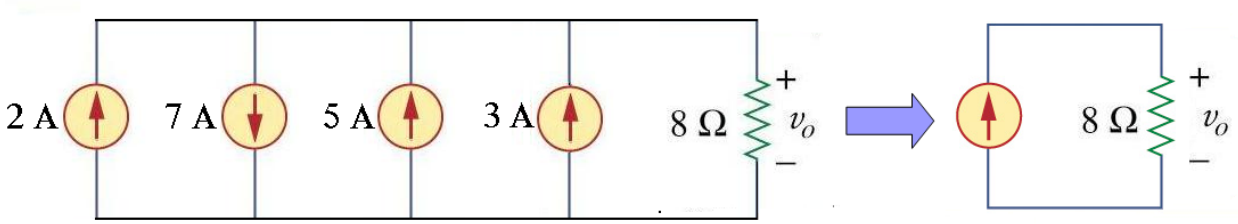
EE301 – Lesson 9
Reading: Sections 8.1-8.5

Example: Determine I_L in the circuit shown below:

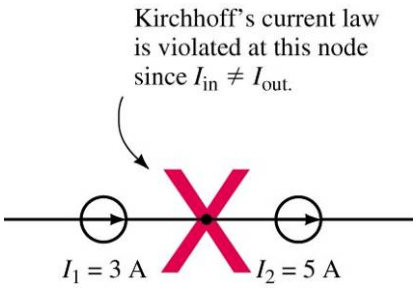


Solution:

Parallel Current Sources Parallel current sources simply add together, and can be simplified by a single current source. The value of the single current source on the right is 3 A.

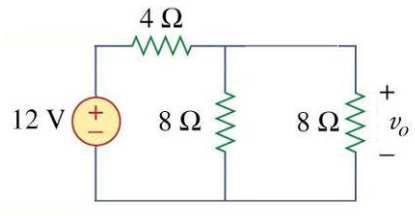


Current Sources in Series Don't ever do this! Civilization will collapse and the world will end. And besides, it's against MIDREGS.



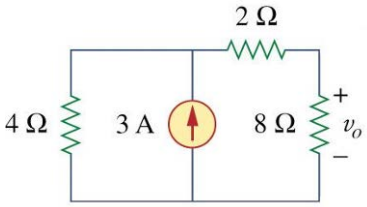
EE301 – Lesson 9
Reading: Sections 8.1-8.5

Example. In the circuit below, use a source transformation to determine v_o.



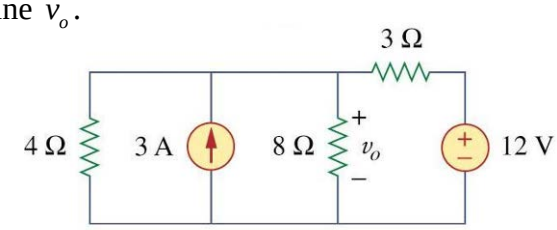
Solution:

Example. In the circuit below, use a source transformation to determine v_o.



Solution:

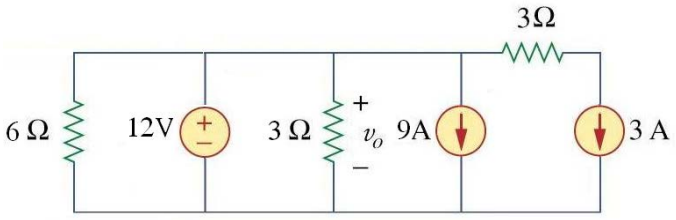
Example. In the circuit below, use a source transformation and the parallel current source rule to determine v_o.



Solution:

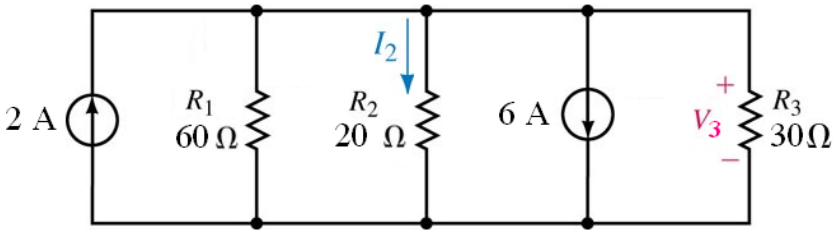
EE301 – Lesson 9
Reading: Sections 8.1-8.5

Example. Determine v_o.



Solution:

Example. Determine I_2 and V_3 in the circuit below.



Solution: