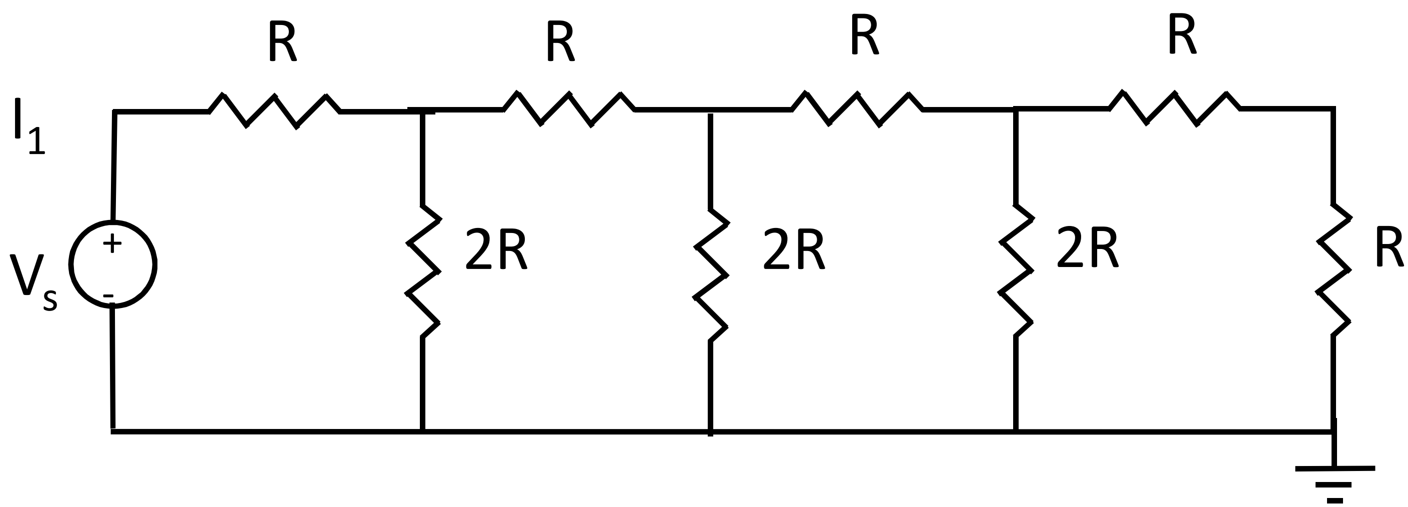
ECE 201, Section 3
Lecture 11

Prof. Peter Bermel

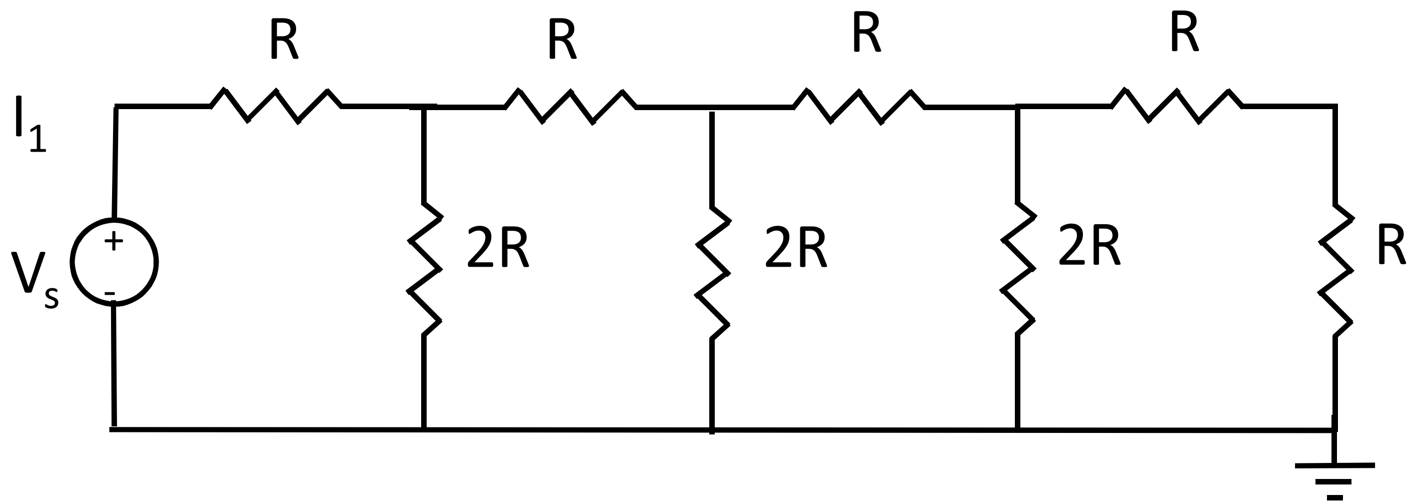
September 14, 2012

Example: Ladder Networks

- Current and voltage everywhere for this 4-loop network? What about *N* loops?



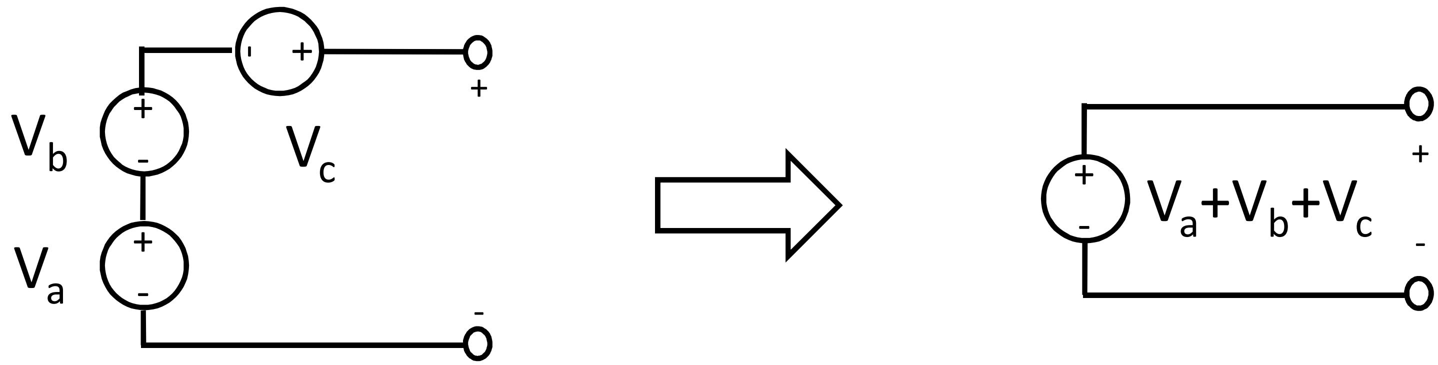
Example Solution



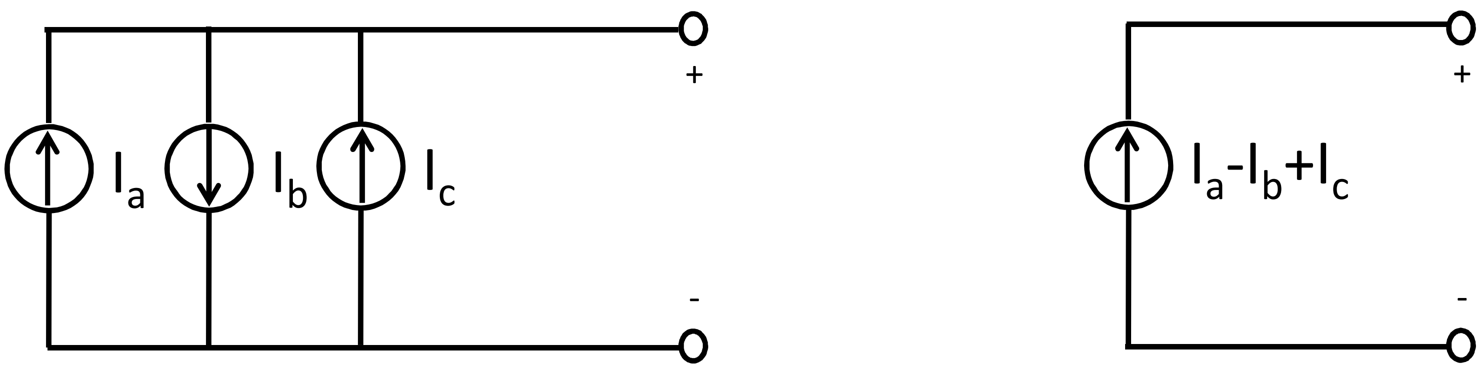
- Assume 1V across resistor at end
- 2V across first loop
- 4V across second loop
- 16 V across fourth loop
- 2^N V with N loops
- Actual voltages: V_s*2^{M-N}

Source Transformations

Combining voltage sources:

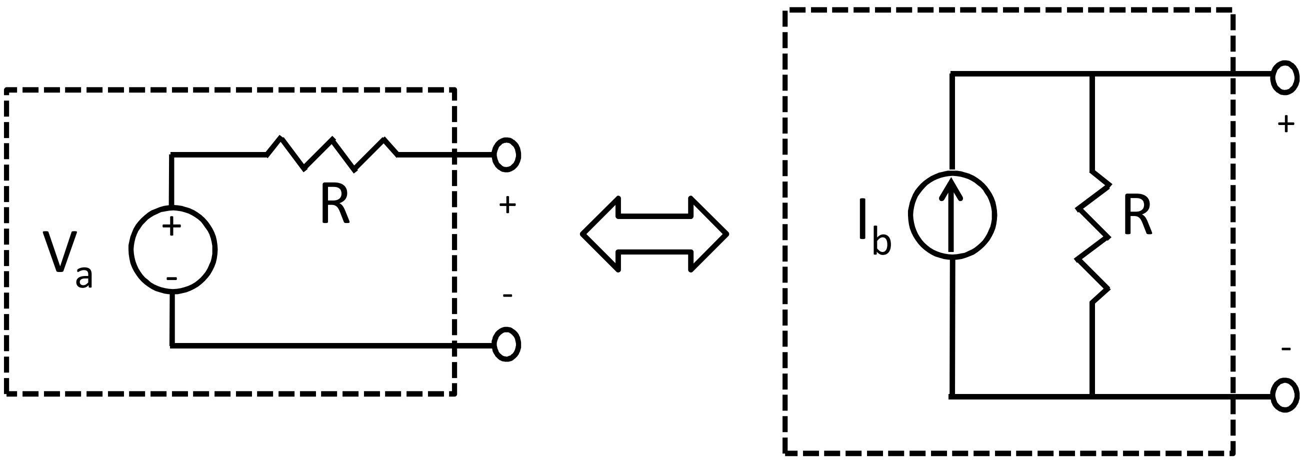


Combining current sources:



Source Transformation Theorem

- These 2-terminal networks are equivalent:
  - Voltage source V_a in series with resistor R
  - Current source I_b=V_a/R in parallel with resistor R



$$V = V_a + IR$$

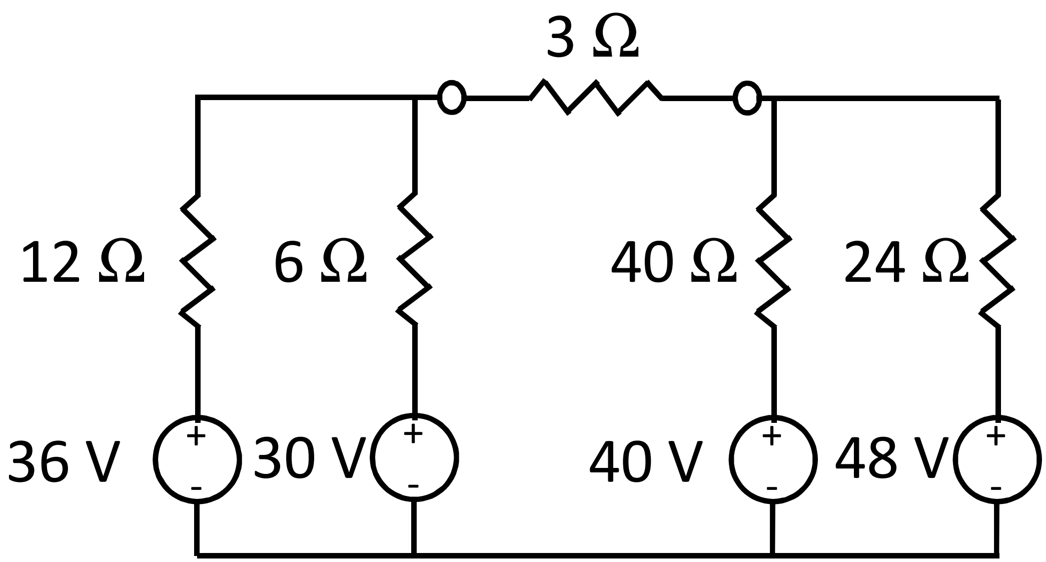
If $V_a = RI_b, V = R(I_b + I)$

$$I = V/R - I_b$$

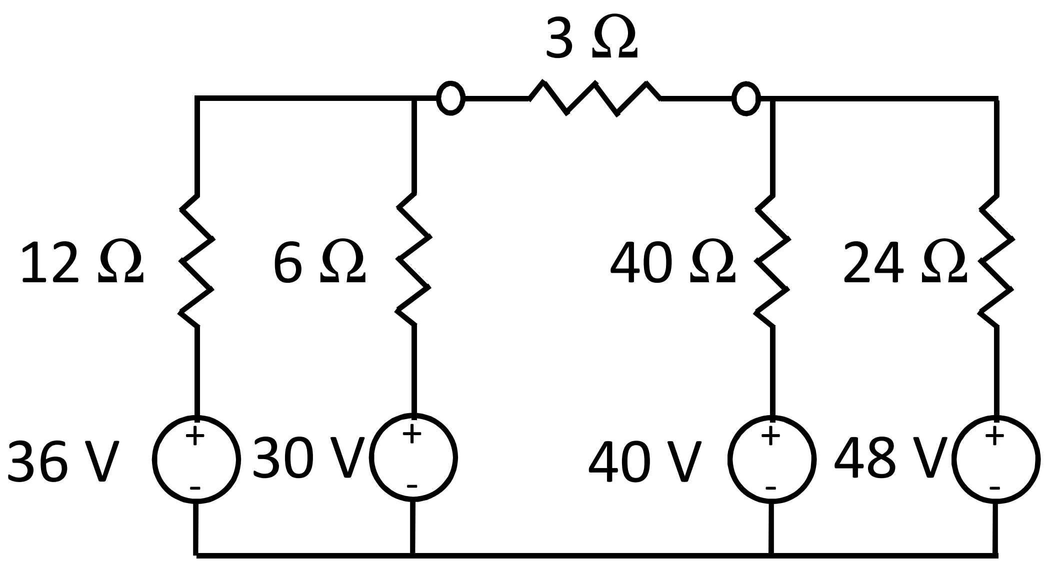
$$V = R(I_b + I)$$

Example 1

- What current flows through the central 3 Ω resistor?

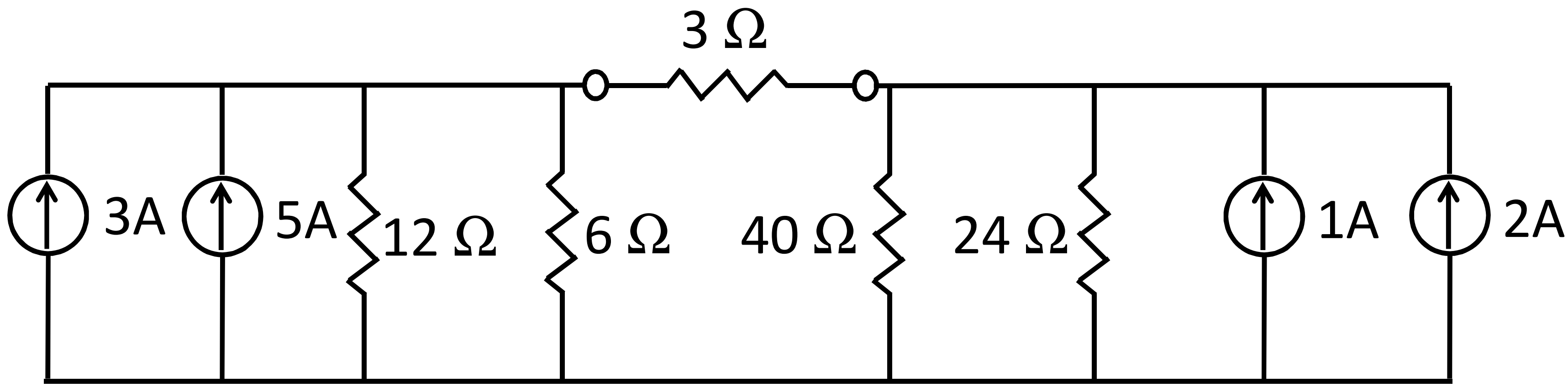


Example 1: Solution



- Rewrite each of the resistor/voltage source pairs as parallel resistor/current source pairs with currents of 36/12=3A; 30/6=5A; 40/40=1A; 48/24=2A

Example 1: Solution

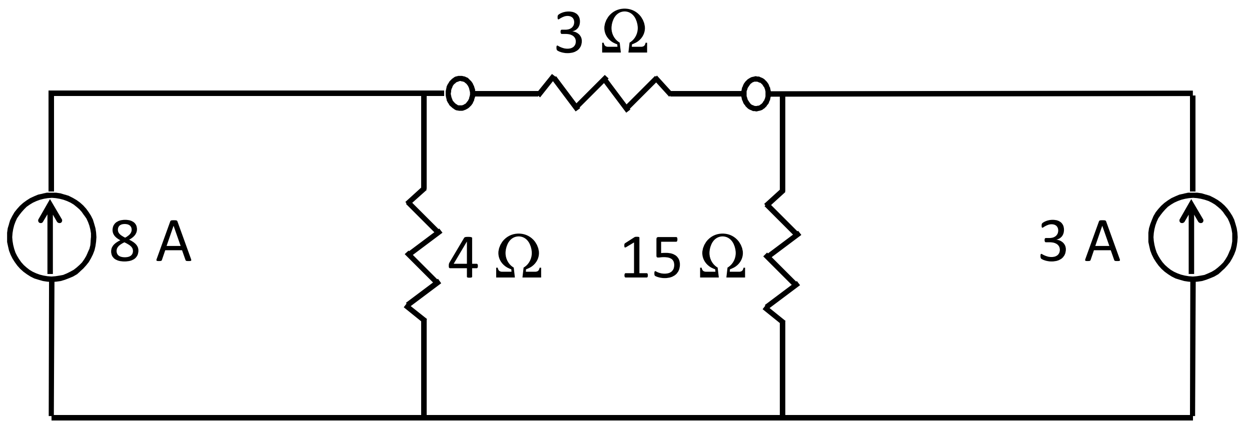


Combine parallel current sources and resistors.

I_L=3+5=8 A; I_R=1+2=3 A

$R_L=(1/6+1/12)^{-1}=4\ \Omega$; $R_R=(1/24+1/40)^{-1}=15\ \Omega$

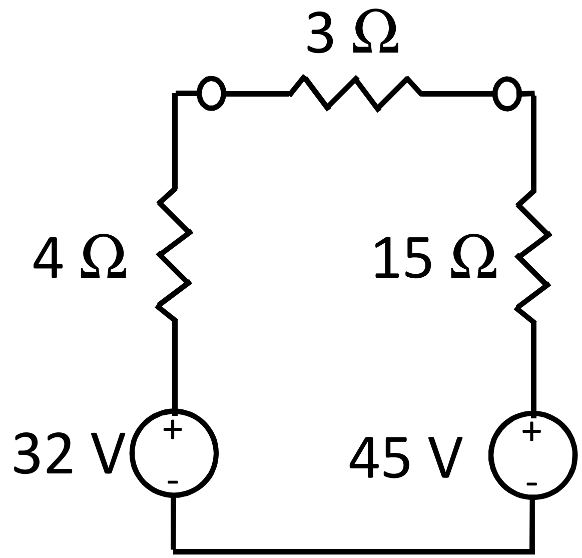
Example 1: Solution



Transform back into V-R pairs:

V_L=32 V; V_R=45 V

Example 1: Solution



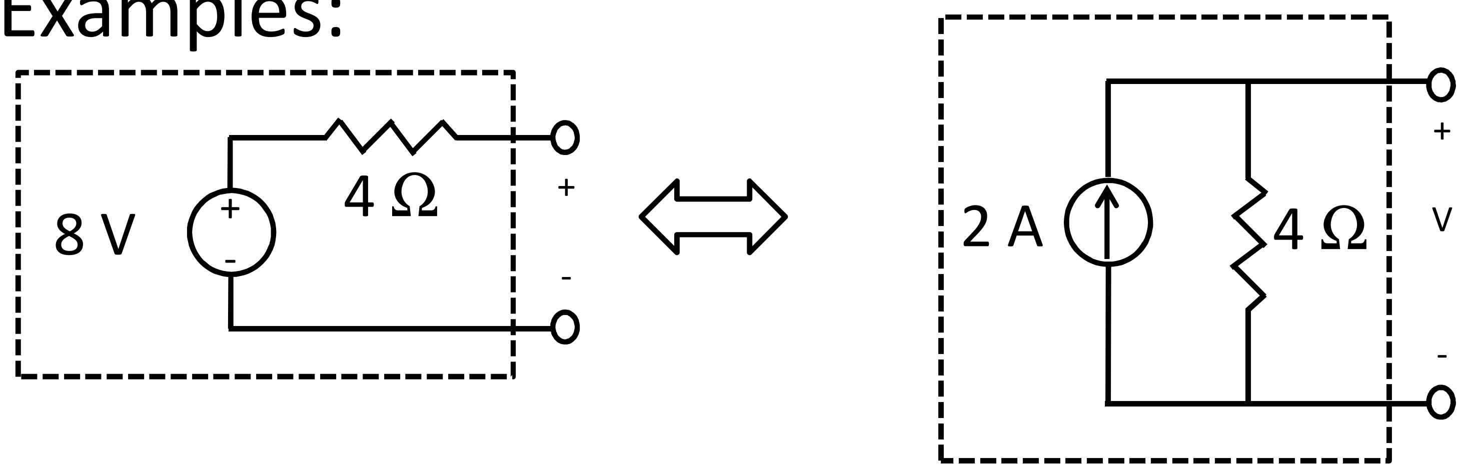
Combine in series:

V=13 V; R=22 Ω

I=V/R=0.59 A

Equivalent Networks

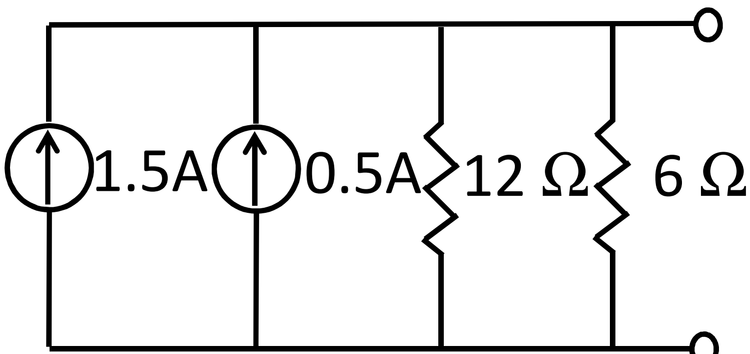
- Equivalent networks: distinct 2-terminal circuits which exhibit the same current-voltage relationship
- Examples:

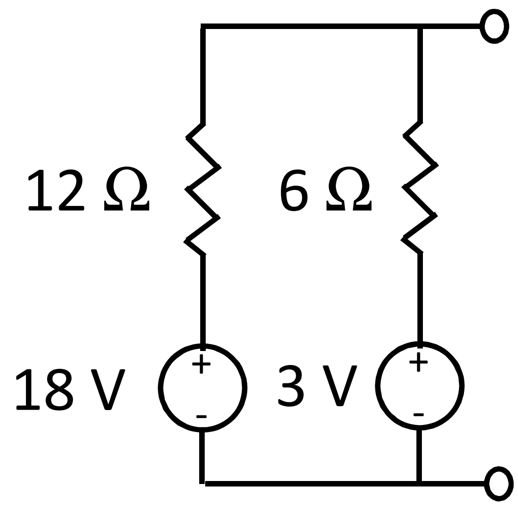


$$V = 8 + 4I$$

$$I = V/4 - 2$$

Equivalent Network Examples



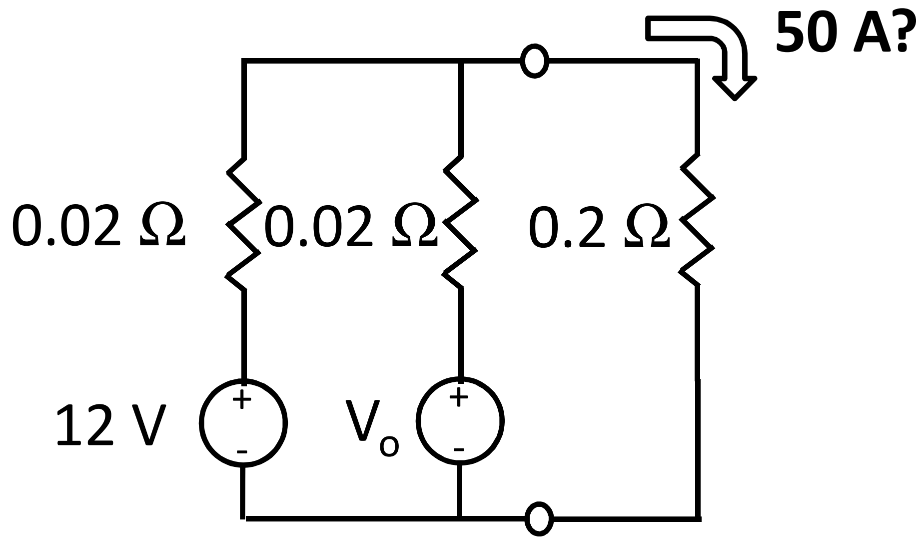


$$I = V/4 - 2$$

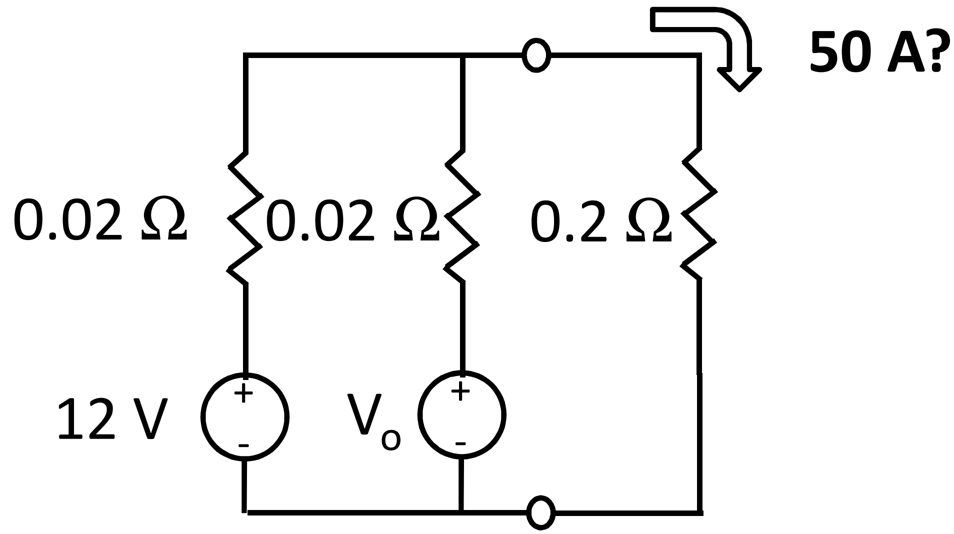
$$V = 8 + 4I$$

Car Battery Problem

- What is the minimum value of Vo required to achieve a 50 A starter voltage?



Car Battery Solution



- Source transformation yields

$I=(12+V_o)/0.02$; $R_{eq}=0.01$ W

$V=6+0.5V_o$

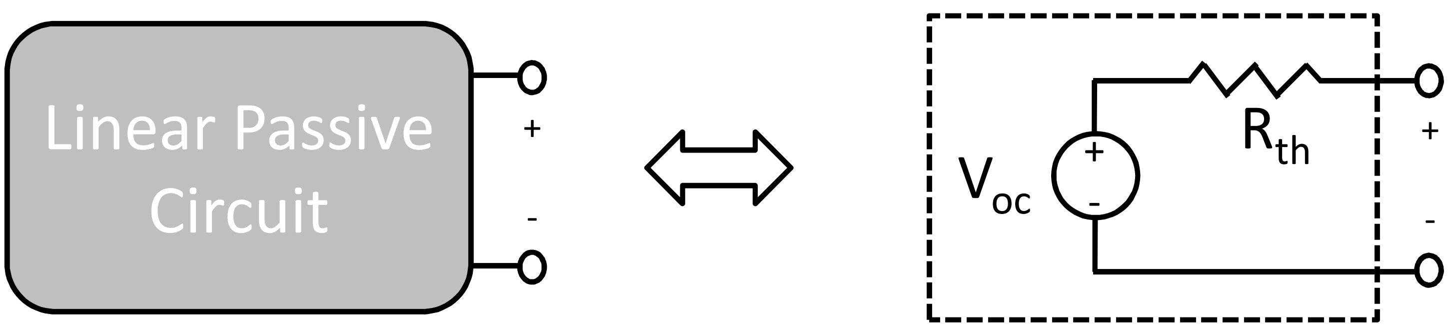
$I=50=(6+0.5V_o)/0.21 \rightarrow V_o=9$ V

Last Lecture on Exam #1

Monday begins Exam #2 material

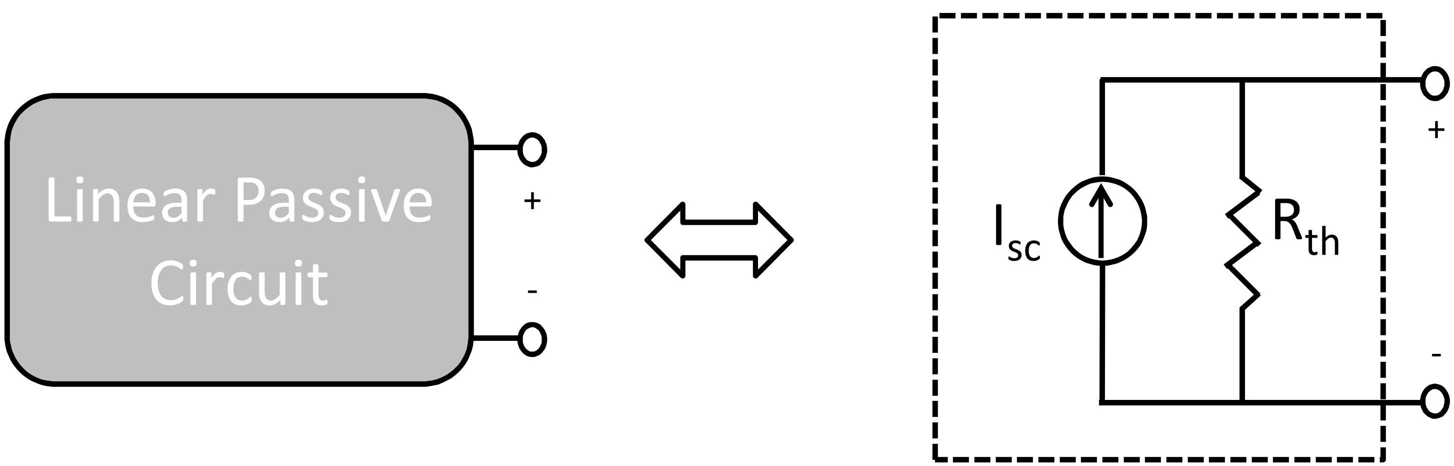
Thévenin's Theorem

- An arbitrary 2-terminal network of independent sources and resistors can be represented by its Thévenin equivalent circuit



Norton's Theorem

- An arbitrary 2-terminal network of independent sources and resistors can be represented by its Norton equivalent circuit



Thevenin and Norton Circuits

- A bare voltage source doesn't have a Norton equivalent
- A bare current source doesn't have a Thévenin equivalent
- When both exist, $V_{oc}=R_{th}I_{sc}$
- Can also deduce Thévenin resistance from:

$$R_{th} = \frac{V_{oc}(t)}{I_{sc}(t)}$$

Homework

- HW #10 due today by 4:30 pm in EE 325B (if no one's there, leave it in an envelope on the door)
- HW #11 due Monday: DeCarlo & Lin, Chapter 5:
  - Problem 40
  - Problem 42
  - Problem 45