Administrivia

- People on the waitlist?
- Midterm stuff
  - Look under Exams link on the EECS 40 homepage
- HW #2 deadline is extended till Friday, July 11th, 12:10 pm.
- HW #3 is up. Due next Wednesday July 16th (before midterm).

Last Time...

- Operational Amplifiers
- **Do you have questions on op-amps?**

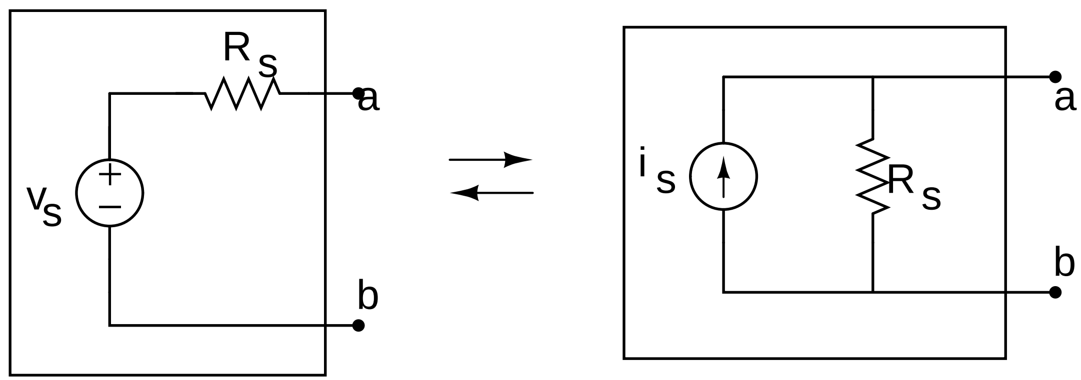
This Time...

- Source transformations
- Maximum power transfer theorem
- Review of circuit analysis

Source transformations

- Another circuit reduction technique - makes life easier if applied quickly and correctly.
- Like the name implies - we can transform a voltage source in series with a resistance to a current source in parallel with a resistance (and vice-versa)

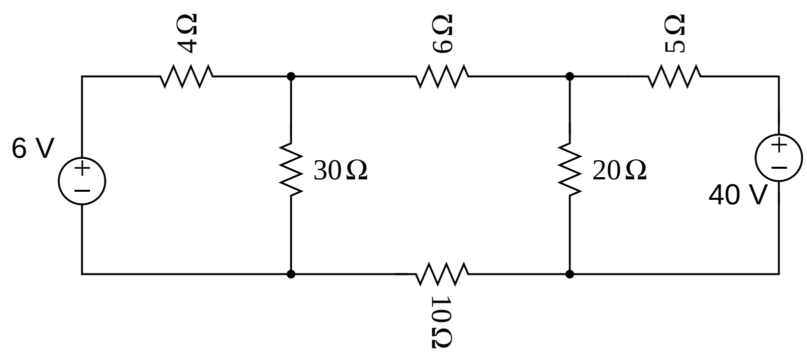
Source transformations - Theory



- We need to find a relationship between i_s and v_s so the two configurations above are equal.
- By "equal" I mean - a load resistor R_L connected across ab experiences the same current flow in both configurations (and hence the same voltage drop in both configurations).
- Note the sign of v_s and the direction of i_s.

Source transformations - example 1

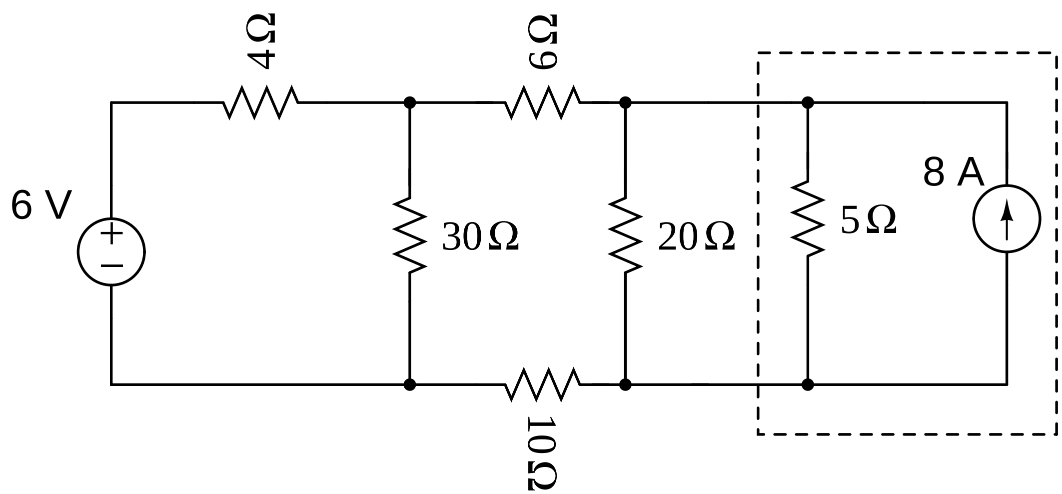
- (Ex. 4.8) Find the power associated with the 6 V source in figure below.



- We can solve this circuit using nodal analysis or thevenin's theorem. If you were to use nodal analysis, you have two unknown nodes. Plus, finding V_{OC} for thevenin's theorem requires a little work. So, lets use source transforms.

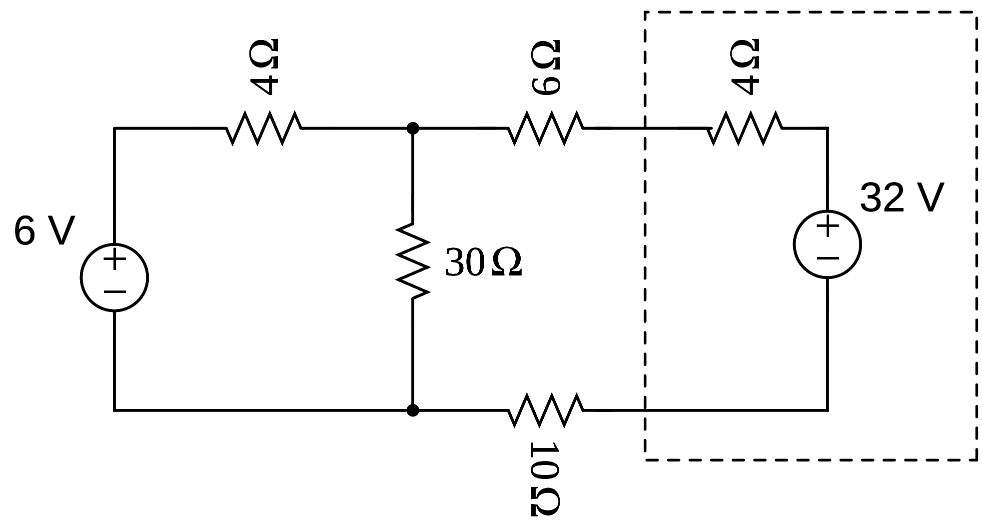
Source transformations - example 1

- Step 1. The dotted box shows the result of a source transform. In this case, I have transformed the 40 V source in series with the 5 Ω to an 8 A current source in parallel with the 5 Ω.



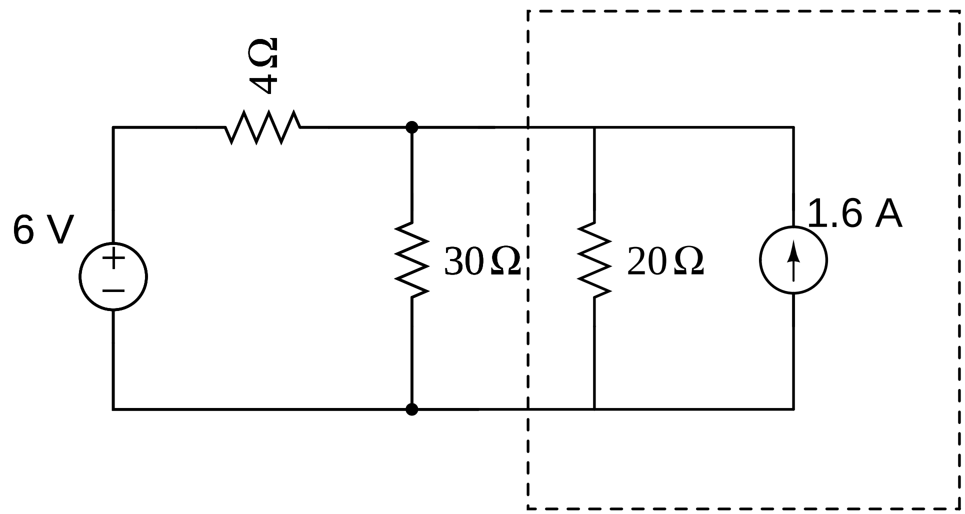
Source transformations - example 1

- Step 2. I was able to combine the 5 Ω and the 20 Ω resistor in parallel to give 4 Ω because of the source transform. Then, I converted the 8 A current source in parallel with the 4 Ω to a 32 V source in series with the 4 Ω.



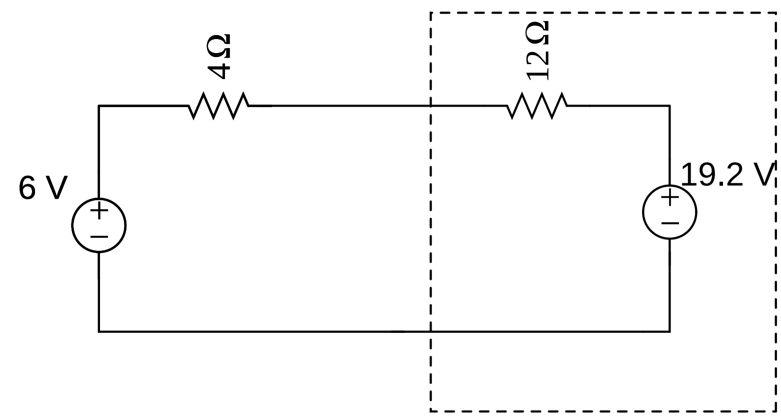
Source transformations - example 1

- Step 3 Now, combine the 6 Ω, 4 Ω and the 10 Ω in series to give 20 Ω. Convert the 20 Ω in series with the voltage source to a 1.6 A current source in parallel with the 20 Ω.



Source transformations - example 1

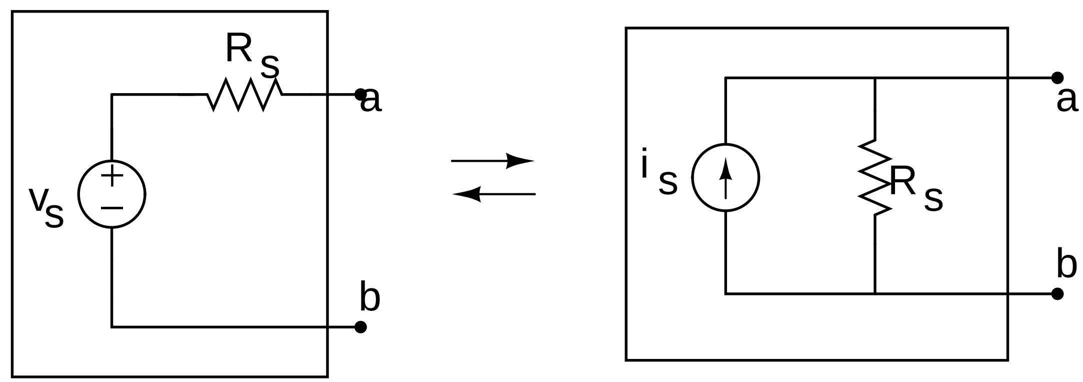
- Step 4 Combine the 20 Ω and 30 Ω in parallel to give 12 Ω. Convert the 12 Ω resistance in parallel with the 1.6 A current source to a 12 Ω resistance in series with a 19.2 V voltage source.



- Now, it is straightforward to find the power dissipated by the 6 V sourc.e. We can see from the figure above that the 19.2 V source is going to charge the 6 V source. The current is going to be $\frac{19.2-6V}{16\Omega}$ = 0.825 Amps. Hence, the power absorbed by the 6 V source is 6 $\times$ 0.825 W = 4.95 Watts

Source transformations - tips

- Concept of a Norton equivalent:

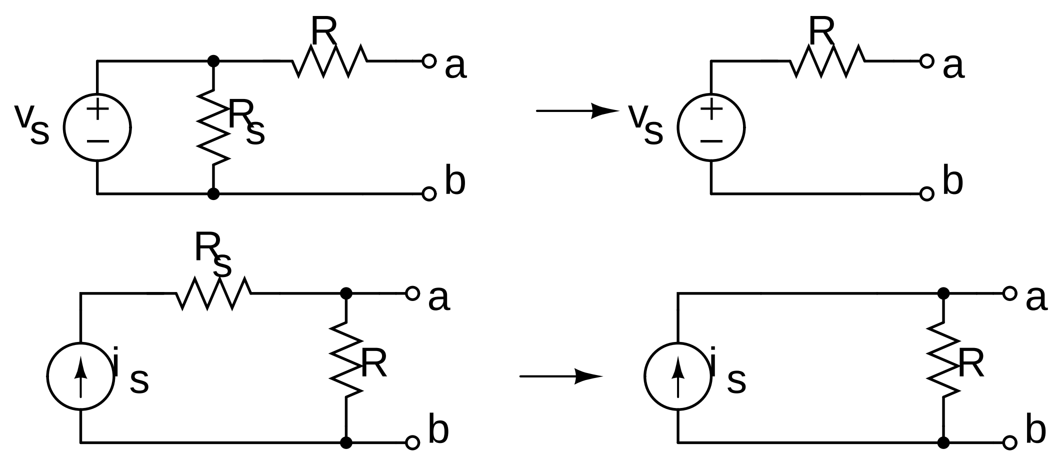


Thevenin Equivalent

Norton Equivalent

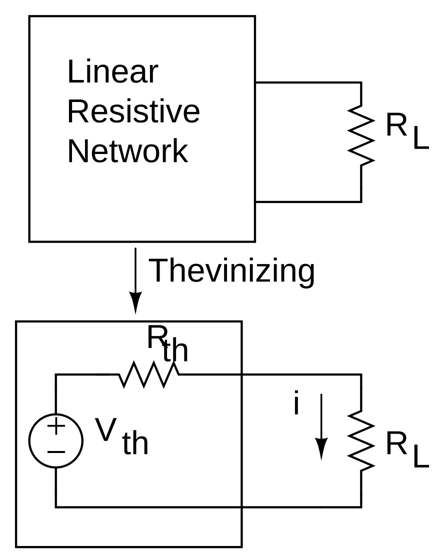
Source transformations - tips

- Other equivalent circuits:



Maximum power transfer theorem

- Concept:



- Question: What value of R$_L$ maximizes the power delivered to R$_L$?
- Application: "Matching" of components in audio system. For example, if the output impedance of an amplifier is 8Ω, it should be used with an u Ω loudspeaker to achieve maximum power output.

Maximum power transfer theorem

- Result: Maximum power is dissipated in R_L when $R_L = R_{th}$
  - Proof: First, the expression for power dissipated in R_L:

$$P(R_L) = i^2 R_L = (\frac{V_{th}}{R_{th} + R_L})^2 R_L$$

  - Differentiate P with respect to R_L, set it equal to zero (V_{th} and R_{th} are given, R_L is the variable).

Review of circuit analysis

- Circuit Analysis Technique: NODAL ANALYSIS. Steps:
  - Select a reference node
  - Label the unknown node voltages
  - Write KCL at each unknown node
  - Use device IV characterstics to rewrite unknown currents in terms of unknown node voltages
  - If you have dependent sources, you need constraint equations.
  - Sometimes a supernode might be useful.
- Circuit Simplification Technique(s):
  - Combining resistors in parallel and series.
  - Voltage and current divider

Review of circuit analysis

- Circuit Simplification Technique(s):
  - Thevenin's theorem
  - Source transformations
  - Norton's theorem
- Applications:
  - RC circuits
  - Op amps
  - Maximum power transfer theorem

Summary

- Official circuit analysis part of the course is over!
- Wrapped up with source transformations and maximum power transfer theorem.

In Conclusion...

- Next time:
  - Guest lecturer: Prof. Tsu-Jae King.
  - Homepage: http://www.eecs.berkeley.edu/˜tking
  - Please skim through chapter 5 in reader.
  - After guest lecture, I will review HW #2.
- REMEMBER CHECK FOR CALBOT KIT - I will talk about Calbot on Monday.
- Questions?