

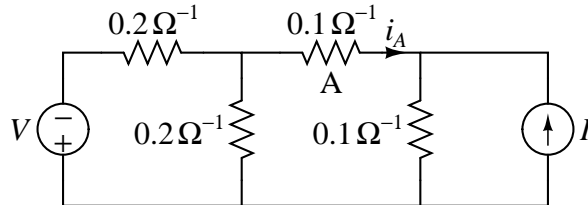
Massachusetts Institute of Technology
Department of Electrical Engineering and Computer Science

6.002 – Circuits and Electronics
Spring 2003

Handout S03-016 - Homework #3

Issued: Thurs. Feb 20
Due: Fri. Feb 28

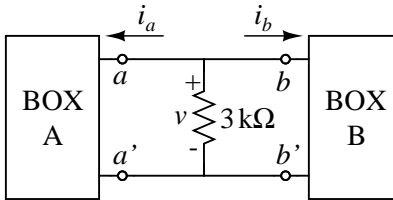
Problem 3.1: This problem is concerned with nodal analysis and the superposition theorem. A linear circuit containing two sources is shown below. Conductance values are in mhos (Ω^{-1}).



- (A) Write node equations which enable the complete determination of the voltages and currents in the circuit.
- (B) Solve these equations for the node to reference voltages (in terms of V and I) and calculate the value of the current i_A (also in terms of V and I) in the resistor marked A . Pay attention to the polarity of i_A !
- (C) Sketch the circuit when the voltage source is acting alone and the current source is dead.
- (D) By inspection, and the use of series-parallel relationships, determine the component of i_A that results from the voltage source alone.
- (E) Sketch the circuit when the current source is acting alone and the voltage source is dead.
- (F) As in Part (D), determine the component of i_A that results from the current source alone.
- (G) Add the components determined in (D) and (F) together. Compare this result for i_A with that you obtained in Part (B).

If the results are not the same, check your answer.

Problem 3.2: This problem is concerned with equivalent circuits. Two gray boxes are connected as shown.

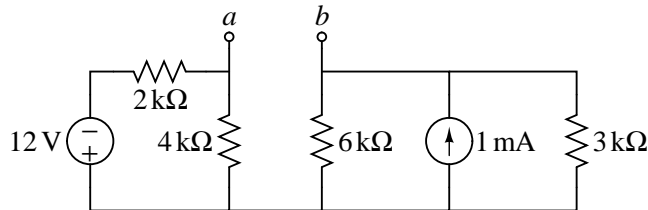


As shown the voltage v across the $3\text{k}\Omega$ resistor is 6V .

When the $3\text{k}\Omega$ resistor is replaced by a short circuit, the currents at the terminals of the boxes are $i_a = -6\text{mA}$ and $i_b = 2\text{mA}$.

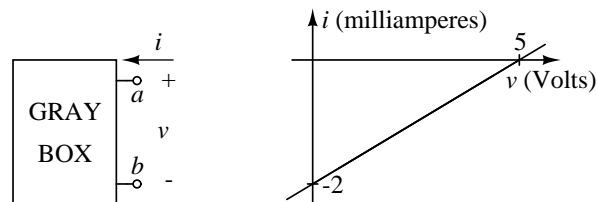
- (A) What is the value of v when the $3\text{k}\Omega$ resistor is replaced by an open circuit (i.e., the resistor is removed)?
- (B) Is there sufficient information to determine the Norton equivalent circuits of each box? Explain.
- (C) You are now free to cut the connections between the boxes. What single measurement would you make on either (but not both) boxes to determine the Norton equivalents of both boxes?
- (D) Assume a value for that measurement and specify the equivalent circuits of each box.

Problem 3.3: Determine the Thevenin equivalent circuit at the terminals indicated of the circuit shown below. Label the terminals and indicate element values and source polarity.

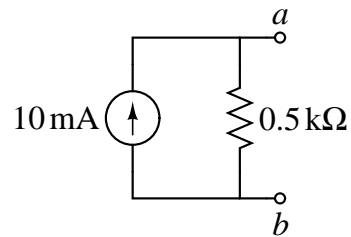


Problem 3.4: This problem concerns Thevenin and Norton equivalents.

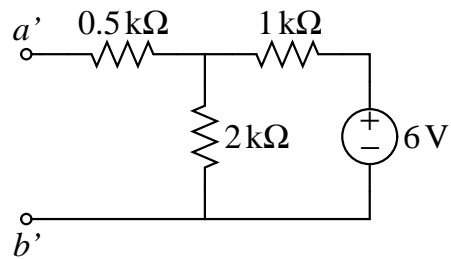
A gray box has the terminal characteristics shown. Devise both Thevenin and Norton equivalent circuits which represent the terminal characteristics of the box. Be sure to show element values and source polarities and label the terminals.



Problem 3.5: A network has the Norton equivalent circuit shown below:



It is connected to the following circuit: terminal a to a' , terminal b to b' .



Determine the power provided by or absorbed by the 6V source. Make clear in your answers direction of power flow at the voltage source.