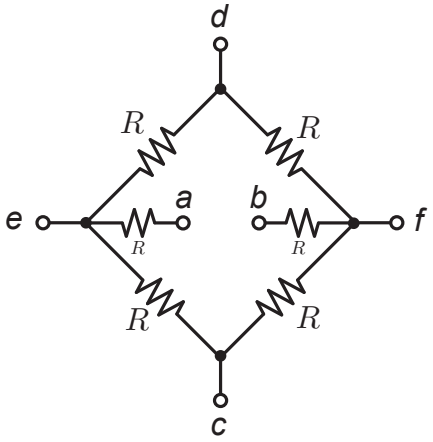
University of California, Berkeley *Spring 2012*
EE 42/100 *Prof. A. Niknejad*

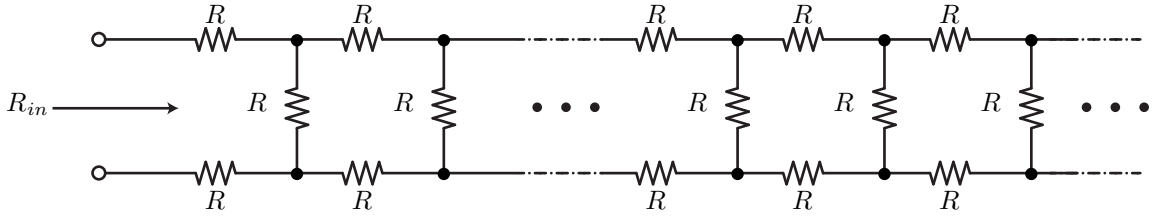
Problem Set 2
Due Wednesday (5pm), February 15, 2012

1. In the following circuit, all resistors are equal. find R_{eq} at terminals a and b if

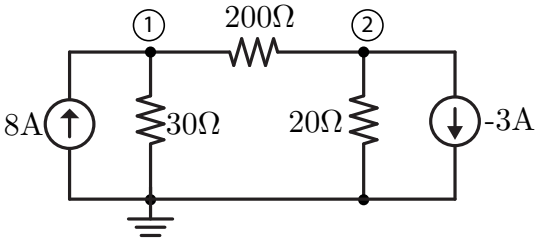


   (a) Terminal c is shorted to terminal d.
   (b) Terminal e is shorted to terminal f.
   (c) Terminal c is shorted to terminal e.

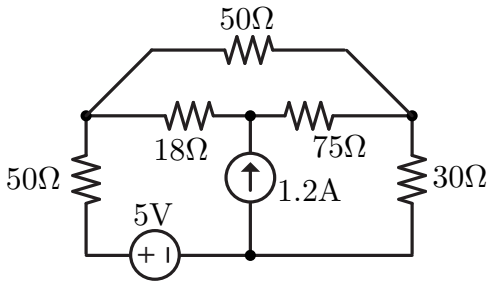
2. For the following infinite "ladder network," find the equivalent input resistance, given that all resistors have a resistance of R. Note that you can make the following assumption in making the calculation. The resistance does not change if we add another ladder section *in front* of the network.



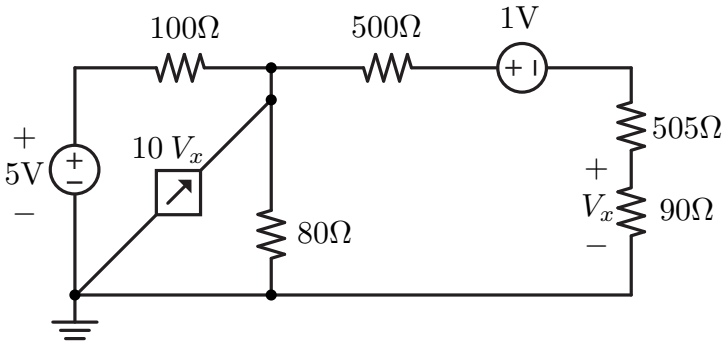
3. Solve for all node voltages using nodal analysis. Verify with superposition.



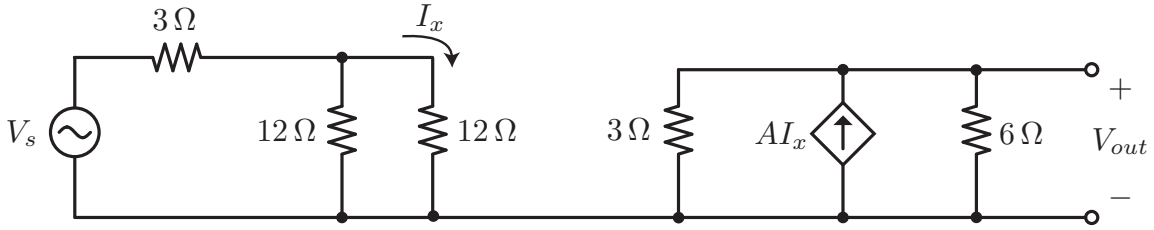
4. For the following circuit: (a) First identify all the nodes in the circuit. (b) Choose a reference node to reduce the number of unknown node voltages. (c) label the remaining node voltages from left to right, top to bottom using letters. (d) Setup the nodal equation and put them in standard form (unknowns on the left hand side, knowns on the right hand side). (e) Solve for the node voltages. (f) Find all the branch currents.



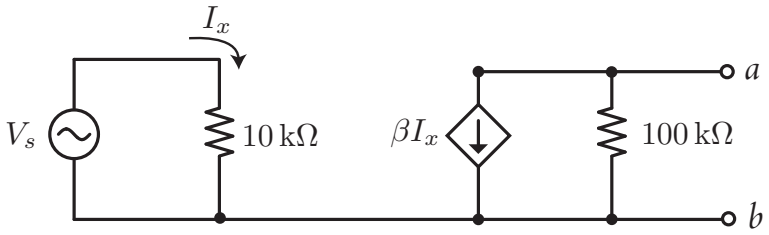
5. Solve for all node voltages using nodal analysis.



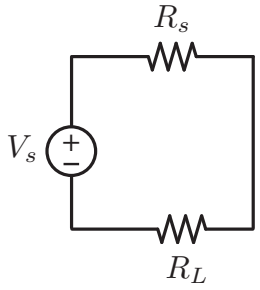
6. Determine the value of A if $\frac{V_{out}}{V_s} = 9$ in the following circuit.



7. Find the Thévenin and Norton equivalents of the following circuit in terms of V_s and β across the terminals a and b.



8. Consider the simple voltage divider circuit shown below. A voltage source V_s with its own source resistance R_s is connected to a load R_L.

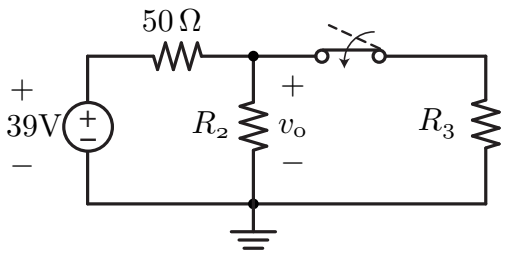


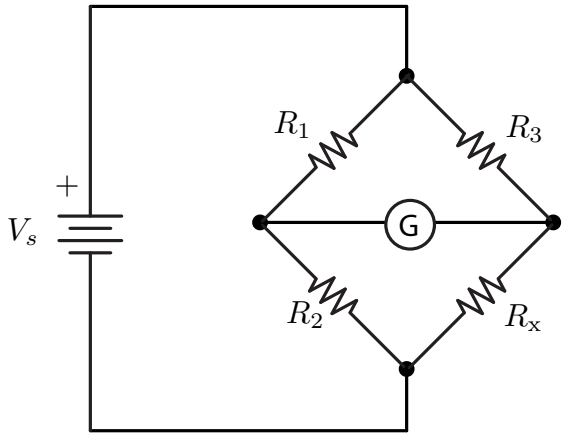
   (a) What should the value of the load be, in terms of R_s, in order to achieve maximum power delivered to it? Find an expression for the power obtained.

   (b) Suppose that instead of achieving maximum power, we want the power delivered to the load to be 80% of the power delivered by V_s. What value should R_L be? Find an expression for the power obtained in this case.

   (c) Why is it that your answer for part (b) does not result in maximum power transferred to the load, even though it results in a greater fraction of power delivered than in part (a)?

9. In the following circuit, the output voltage v_o is either 26 V or 24 V, depending on whether the switch is open or closed. For which state is $v_o = 24$ V? Find R_2 and R_3.





10. Consider the above circuit, known as the Wheatstone bridge. Its functionality allows one to measure resistance very precisely. It is used in many applications, like strain gauges and thermocouples.

    (a) We say that the bridge is balanced when the current across the galvanometer (or in modern days an ammeter) in the middle is 0. Derive a relationship for the unknown resistance R_x in terms of the other three resistances if this is the case.

    (b) We can thus find one resistance if we know the other three. Suppose $R_1 = 50\,\Omega$, $R_3 = 100\,\Omega$, and R_2 can be adjusted in increments of $10\,\Omega$ from 0 to $1000\,\Omega$. What is the maximum resistance that can be measured for R_x, and what is the accuracy of this measurement?

    (c) Find the Thévenin equivalent, in terms of R_1, R_2, R_3, R_4, and V_s, of the Wheatstone bridge as seen by the galvanometer.