ECE 207 – CONTROLLED SOURCES – INVESTIGATION 5
CIRCUITS WITH CONTROLLED SOURCES – PART I

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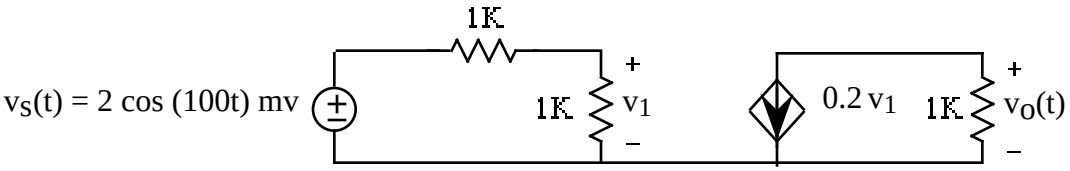
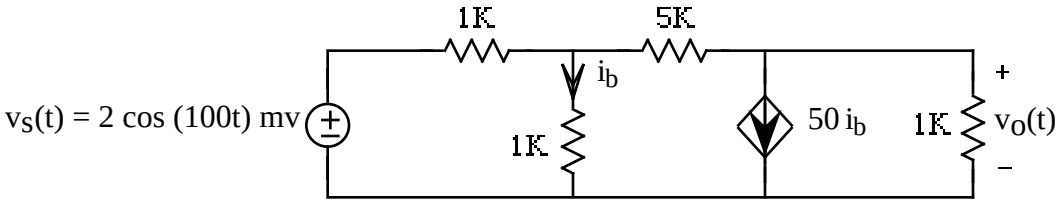
To do "well" on this investigation you must not only get the right answers but must also do neat, complete and concise writeups that make obvious what each problem is, how you're solving the problem and what your answer is. You also need to include drawings of all circuits as well as appropriate graphs and tables.

The main objectives of this investigation are to get practice analyzing resistor circuits with controlled sources and to demonstrate the fact that these circuits have equivalent resistances and transfer functions just like purely resistor circuits do.

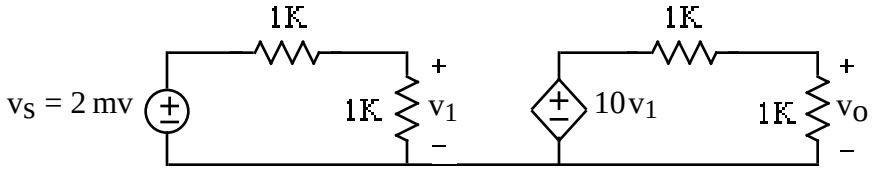
1. Find $v_o(t)$ in the following circuit



2. Find $v_o(t)$ in the following circuit. Identify the auxiliary equation for i_b

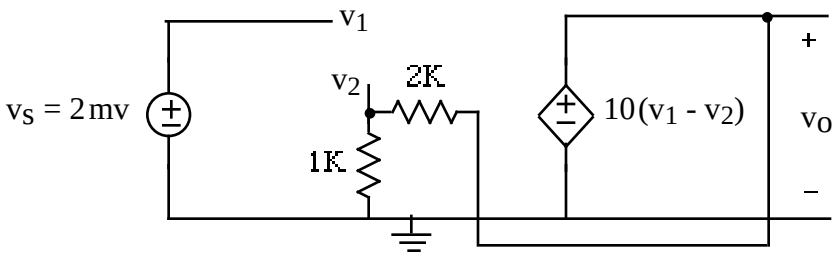


3. Find v_o in the following circuit



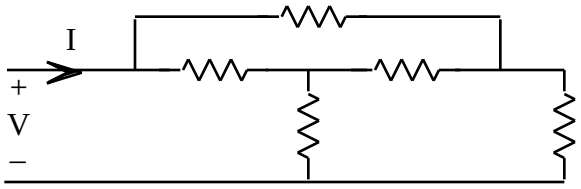
Be careful - don't write an equation at the node with the controlled voltage source connected to the reference. It will give you another equation but also another unknown - the current I through the controlled source

4. Find v_o in the following circuit

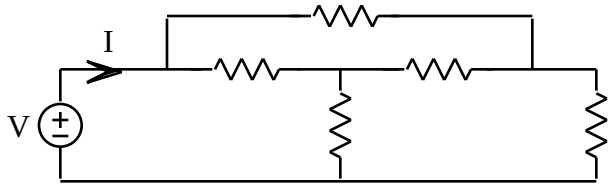


where the dependent voltage source is controlled by the difference between voltages v_1 and v_2.

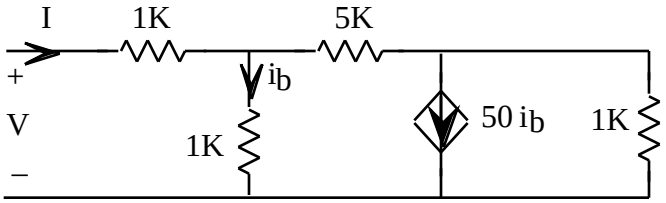
5. We know from Review Investigation 3 that every resistor circuit like the following



is equivalent to a single resistor R_{eq} which we can obtain by connecting up a voltage source as follows

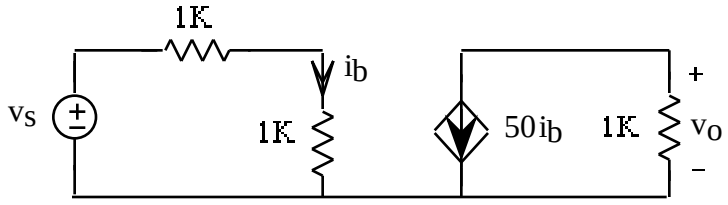


and then making use of node analysis to obtain $R_{eq} = V/I$. Now suppose we have a resistor circuit that contains a controlled source like the following



a. Show that V is proportional to I for this circuit and so it too has an equivalent resistance R_{eq} just like pure resistor circuits do. Draw its equivalent resistance
b. Make use of your result in part (a) to find i(t) when $v_S(t) = 5 \cos(1000t)$

6. Generalizing on the analysis of Problem (5) it can be shown that all voltages and currents in resistor circuits containing controlled sources are proportional to the circuit's independent sources. And so we can find transfer functions for the voltages and currents in circuits like the following



a. Find the transfer function $G = V_O/V_S$ of this circuit
b. Make use of your result in part (a) to find $v_O(t)$ when $v_S(t) = 5 \cos(1000t)$

7. Math Review - Find and sketch the solution to the following Differential Equation for $t \geq 0$ using the Cookbook method presented in Investigation 4.

$$x' + 20x = 50 \qquad x(0) = -2$$