Physics 536 - Assignment #1

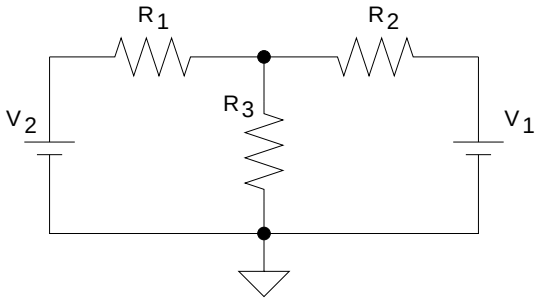
1. Printed circuit boards are often manufactured adhering a very thin layer of copper to a sheet of epoxy impregnated fiberglass and etching away the unwanted copper to leave behind traces that form the conductors in a circuit. The thickness of the copper cladding is specified in *ounces per square foot*.

(a) Calculate the thickness in mils and millimeters of 1-oz, 2-oz and 0.5-oz copper.

(b) Calculate the resistance of a trace that is 1 inches long and 5 mils in diameter for 1-oz, 2-oz and 0.5-oz copper at room temperature (~ 300 K).

(c) What are the resistance of these traces if their temperature increases by 100° C?

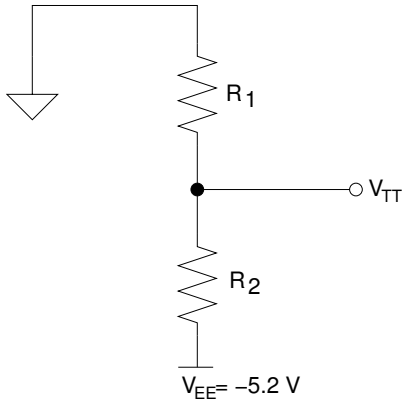
2. Calculate the currents, I_1 and I_2 that flow through the voltage sources V_1 and V_2, respecively, in the circuit shown below:



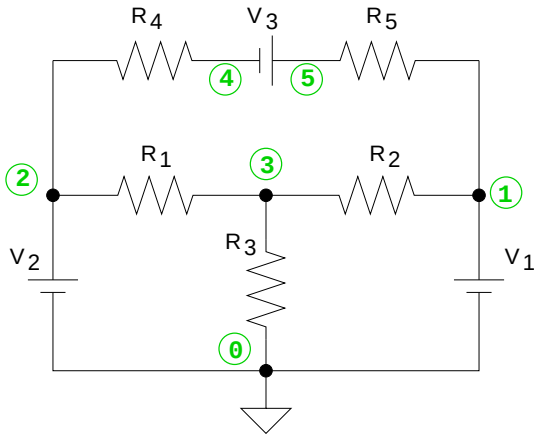
Be sure to clearly identify the assumed direction of current flowing through each voltage source.

3. A *non-ideal* voltage source provides a voltage V when no load is attached. If a load of resistance R_L is connected to this voltage source and the voltage across R_L is now found to be V', calculate the impedance of the voltage source in terms of R_L, V and V'.

4. In the following circuit, what values of resistors R_1 and R_2 will provide a voltage source, V_{TT},, with a voltage of -2 V (with no load attached) and an impedance of 50 Ω?



5. Consider the following circuit which contains three loops:



(a) Assign currents I_1, I_2 and I_3 flowing *clockwise* through the three loops containing voltage sources V_1, V_2 and V_3, respectively. Then write the 3×3 matrix equation that relate the currents, resistances and voltage sources. You do not need to solve this system of equations.

(b) Suppose the components in the circuit had the following values:

$$\begin{aligned} V_1 &= 5\ \text{V} \\ V_2 &= 10\ \text{V} \\ V_3 &= 5\ \text{V} \\ R_1 &= 10\ \Omega \\ R_2 &= 20\ \Omega \\ R_3 &= 5\ \Omega \\ R_4 &= 10\ \Omega \\ R_5 &= 10\ \Omega \end{aligned}$$

Following the example provided at

`http://www.physics.purdue.edu/~jones105/phys536/spice.html`

write the SPICE netlist that describes this circuit using the node numbers indicated.