EE 40
Midterm #1 Review

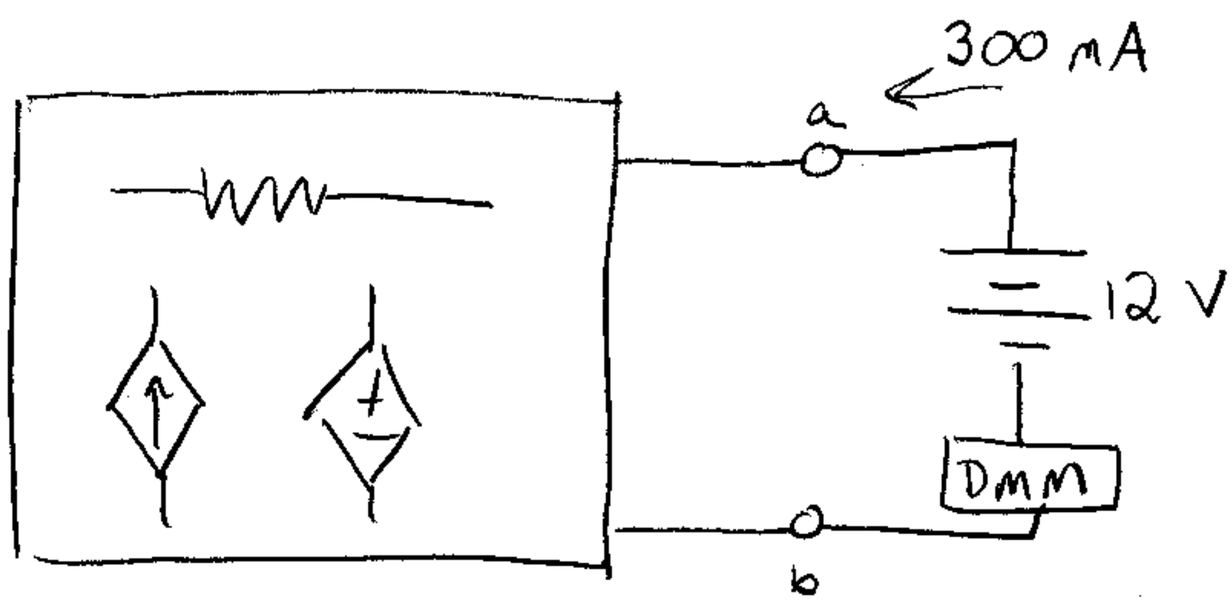
Problems inspired by supplemental text, Electric Circuits by Nilsson and Riedel.

<u>Problem 1:</u> I picked up my calculator yesterday, and realized I hadn't changed the batteries since I took an electric circuits course.

Suppose the batteries supplied my calculator with a constant 50 μA for 1000 hours.
During that time, the voltage supplied by the batteries decreased linearly with time, from 6V at the start to 5V after 1000 hours.

How much energy did these batteries deliver over the 1000 hour period?

<u>Problem 2:</u>



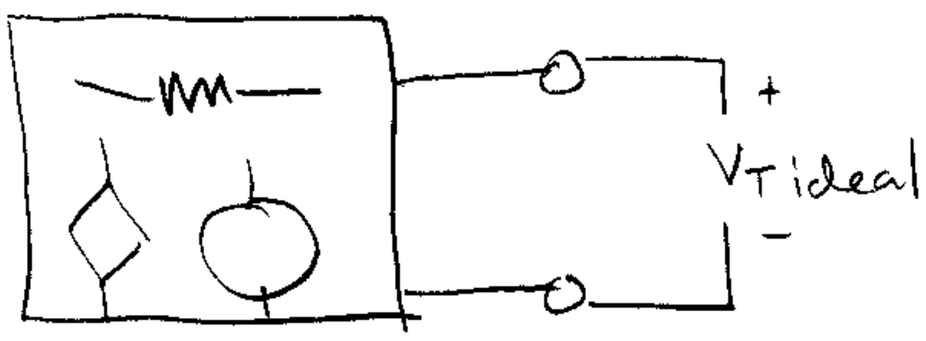
I am trying to find a Thevenin equivalent for a circuit which contains only resistors and linear dependent sources (all controlling voltages & currents inside).

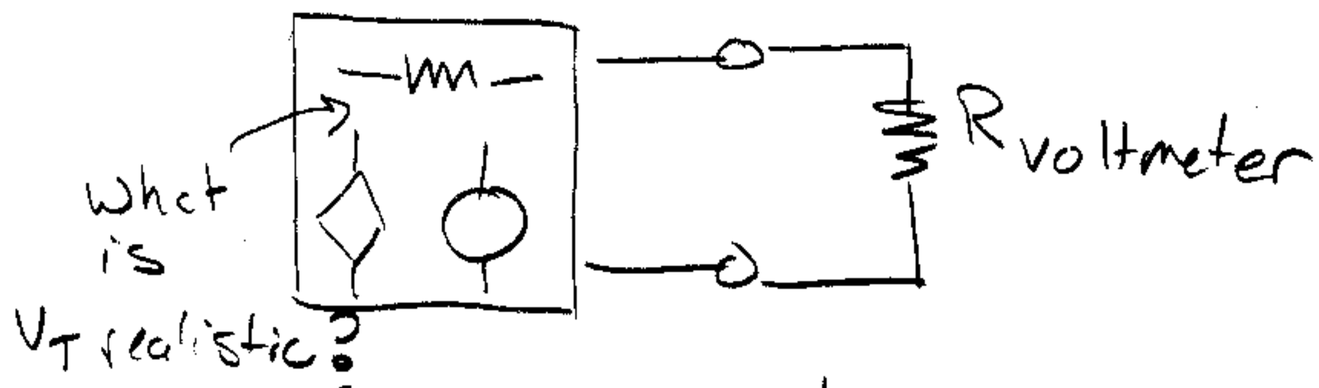
I make one measurement: I apply a 12 V battery with internal resistance 9 Ω and measure 300 mA as shown with an ammeter, internal resistance 1 Ω. Can I find the equivalent?

Problem 3:

Consider any linear circuit.

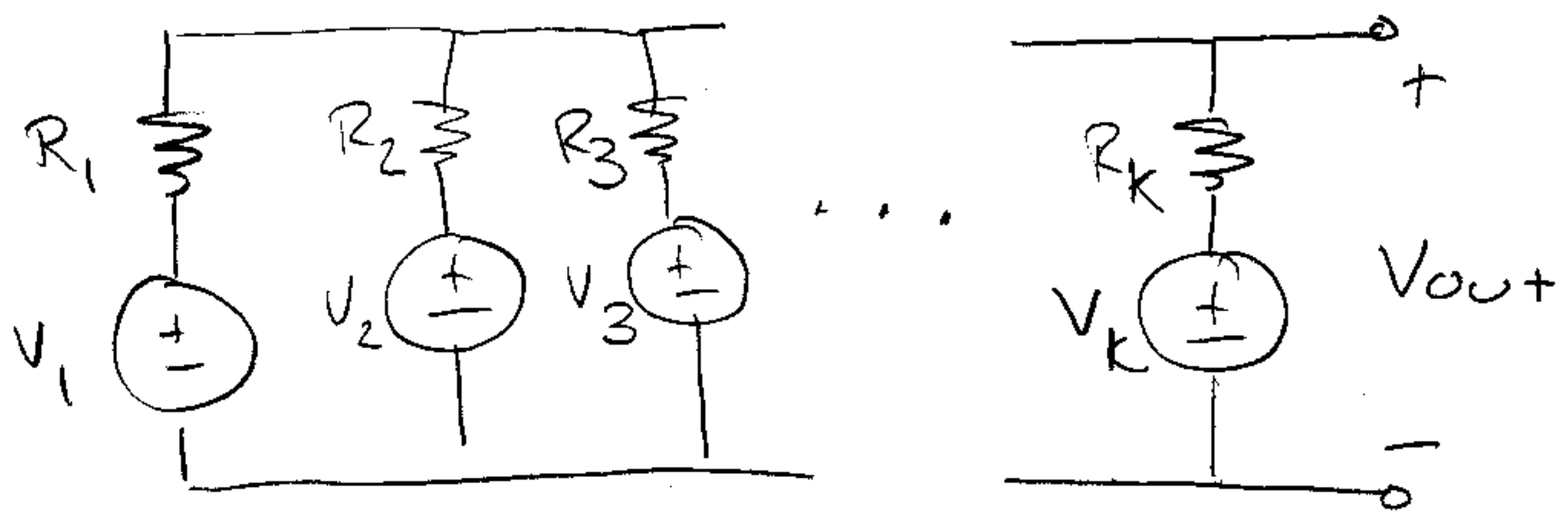
Suppose I measure V_T using a voltmeter and assuming the voltmeter is ideal. Call this $V_{T\,ideal}$. If I later take the voltmeter resistance into account, should my new estimate, $V_{T\,realistic}$, be larger or smaller (in magnitude) than $V_{T\,ideal}$?





Now make the same comparison for an ammeter: Measure the Norton current $I_{N\,ideal}$ assuming an ideal ammeter. When I take the ammeter resistance into account, should my new estimate $I_{N\,realistic}$ be larger or smaller in magnitude than $I_{N\,ideal}$?

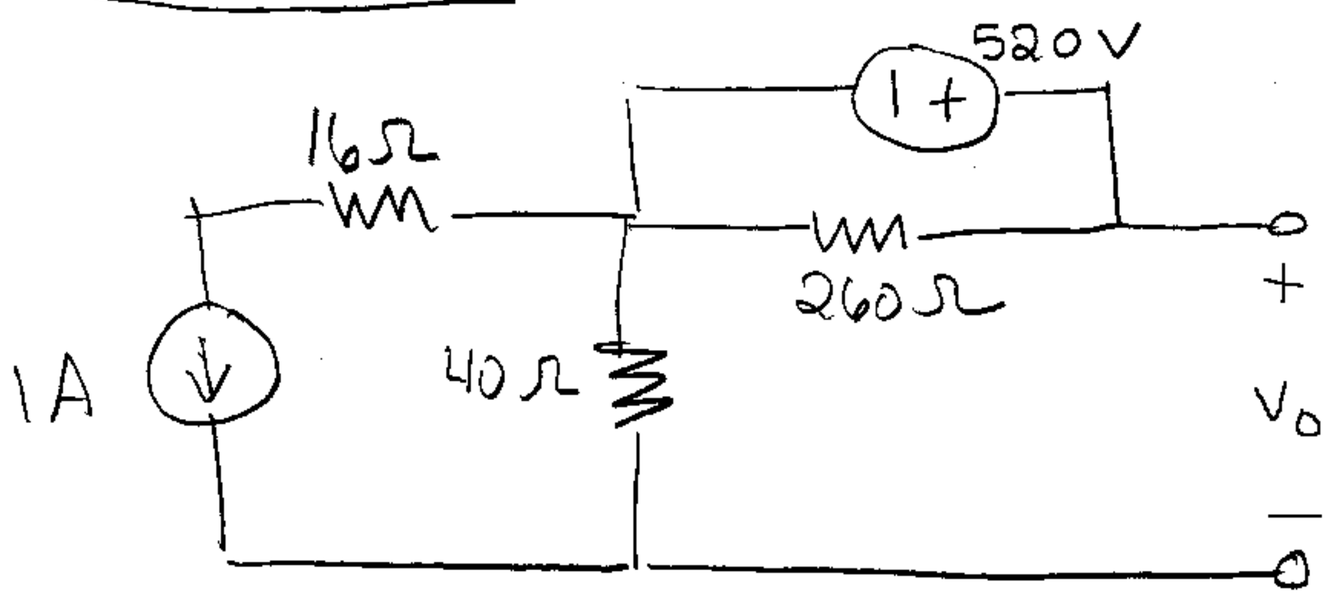
Problem 4:



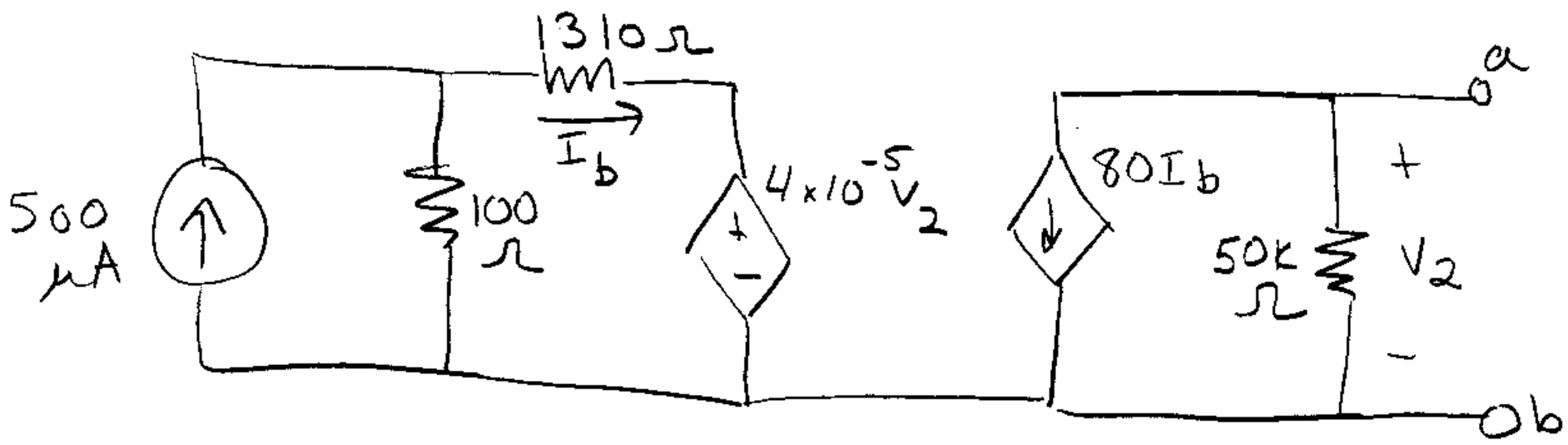
a) Show that if $R_1 = R_2 = \dots = R_K$, V_{out} is the average of $V_1, V_2, \dots V_K$.

b) Show that in general, V_{out} is a linear combination of $V_1, V_2, \dots V_K$. That is, $V_{out} = a_1 V_1 + a_2 V_2 + \dots a_K V_K$ where $a_1, \dots a_K$ are constants depending on resistors.

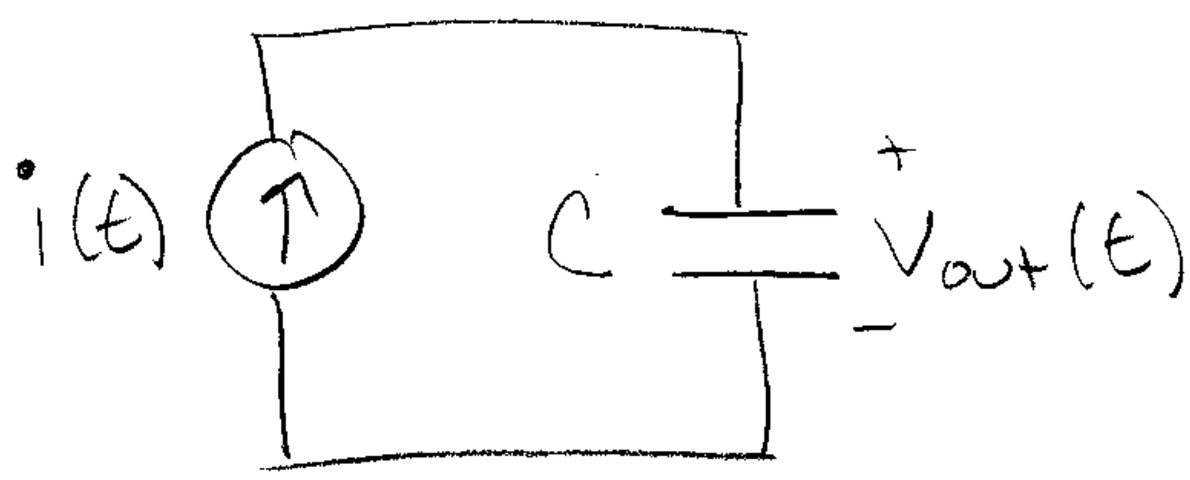
Problem 5: Find V_o.



Problem 6: This circuit is similar to the internal (small-signal) model of a bipolar junction transistor. Find the Thevenin and Norton equivalents w.r.t. a + b.



Problem 7:



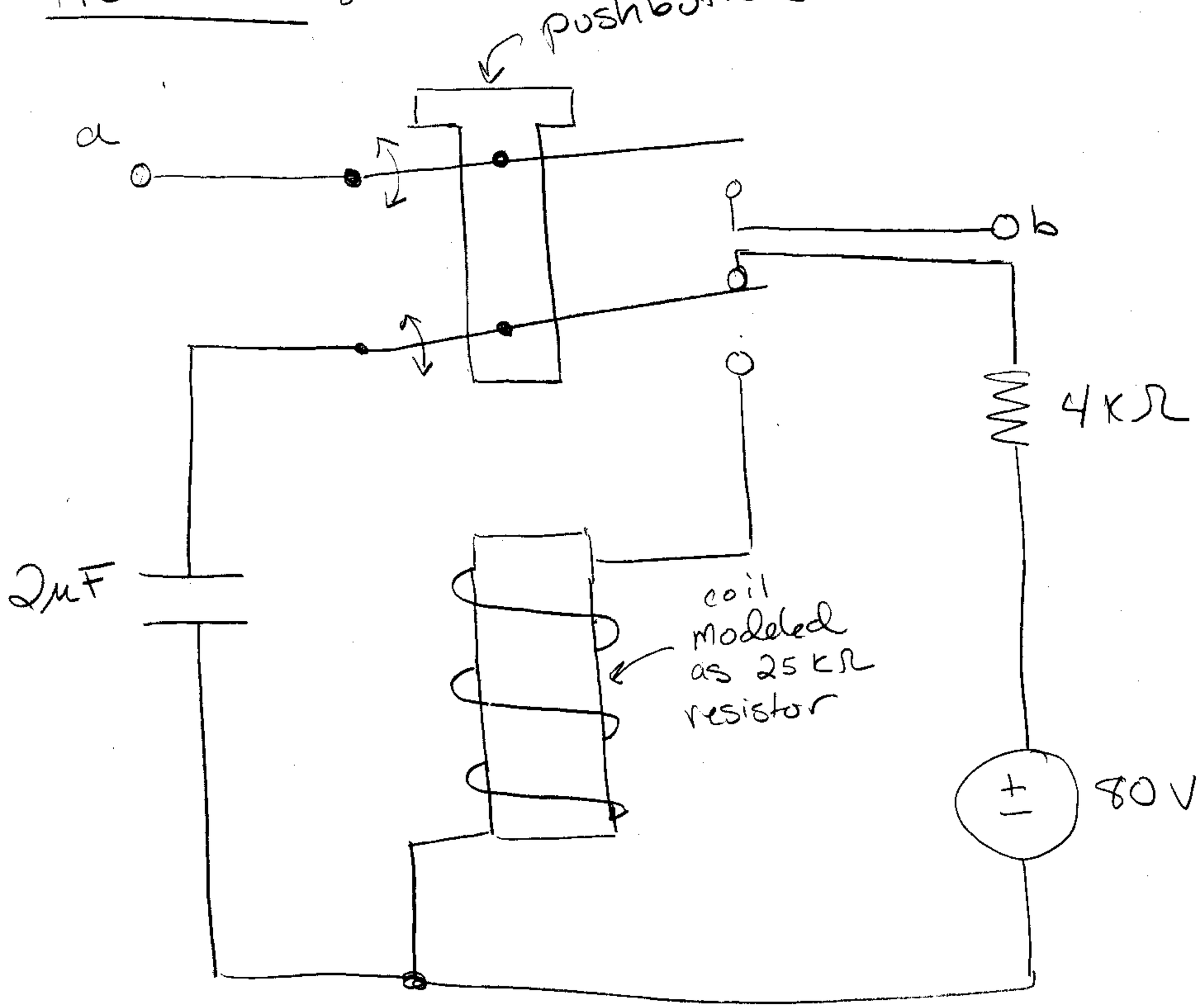
Assume $V_{out}(0) = 0\,V$.

Find $V_{out}(t)$ if:

a) $i(t) = I_s$ (constant)

b) $i(t) = \cos(\omega t)$

Problem 8:



The circuit above is used to connect point a to point b for a certain length of time.

The connection between a & b is made when the pushbutton is depressed, or when the coil voltage exceeds 5V. When the voltage over the coil equals 5 V, the switch returns to the position shown above by a spring action.

Suppose the capacitor is initially fully charged, and at $t=0$, I push down the pushbutton (and immediately let go). How long will the connection from a to b be maintained?