Name: ____________________________ (please print)

Signature: _________________________

ECE 2300 – Quiz #5
April 11, 2012

Keep this quiz closed and face up until you are told to begin.

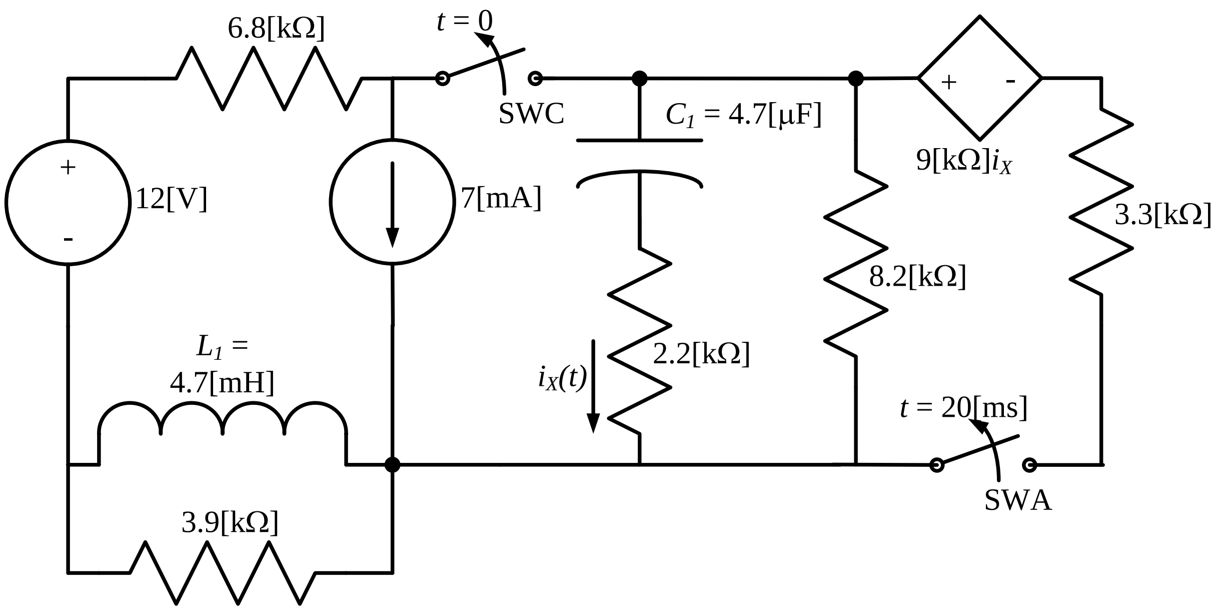
1. This quiz is closed book, closed notes. You may use one 8.5” x 11” crib sheet, or its equivalent.
2. Show all work on these pages. Show all work necessary to complete the problem. A solution without the appropriate work shown will receive no credit. A solution which is not given in a reasonable order will lose credit.
3. It is assumed that your work will begin on the same page as the problem statement. If you choose to begin your work on another page, you must indicate this on the page with the problem statement, with a clear indication of where the work can be found. **<u>If your work continues on to another page, indicate clearly where your work can be found. Failure to indicate this clearly will result in a loss of credit.</u>**
4. Show all units in solutions, intermediate results, and figures. Units in the quiz will be included between square brackets.
5. Do not use red ink. Do not use red pencil.
6. You will have 40 minutes to work on this quiz.

_______________/20

Room for extra work

Use the circuit below to solve this problem. The two switches were closed for a long time before $t = 0$, at which time switch SWC opened. Then, 20[ms] later, switch SWA opened.

a) Find $i_X(0^-)$.
b) Find $i_X(0^+)$.
c) Find $i_X(10[\text{ms}])$.

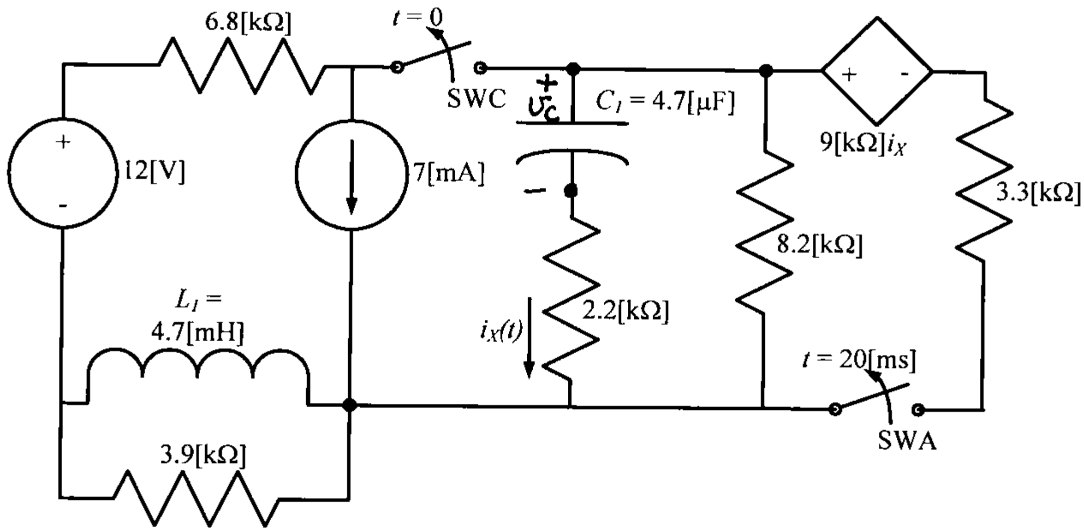


Room for extra work

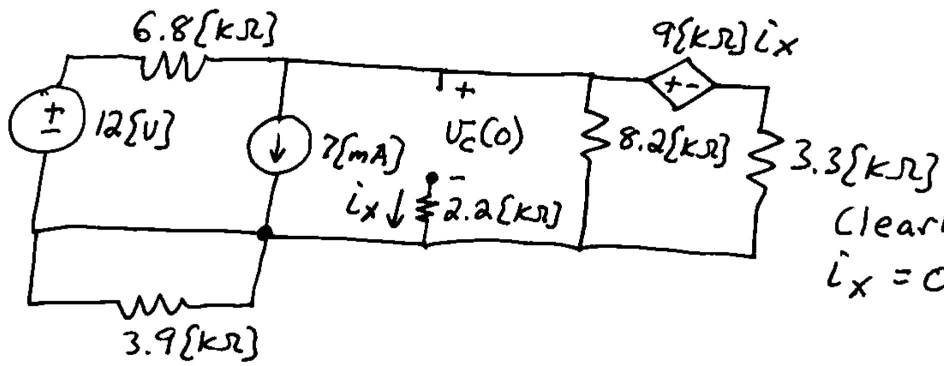
ECE 2300 -- Quiz #5 – April 11, 2012 – Solution

Use the circuit below to solve this problem. The two switches were closed for a long time before $t = 0$, at which time switch SWC opened. Then, 20[ms] later, switch SWA opened.

a) Find $i_X(0^-)$.
b) Find $i_X(0^+)$.
c) Find $i_X(10[\text{ms}])$.



We begin by defining the voltage across the capacitor C_1, which we have done in the diagram above. Then, to get the initial condition, we use the steady-state conditions, and redraw for $t<0$:



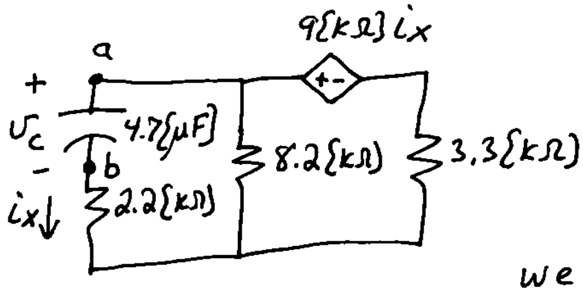
Clearly, $i_X = 0$. So

$$7[\text{mA}] + \frac{v_C(0) - 12[\text{V}]}{6.8[\text{k}\Omega]} + \frac{v_C(0)}{3.3[\text{k}\Omega]} + \frac{v_C(0)}{8.2[\text{k}\Omega]} = 0$$

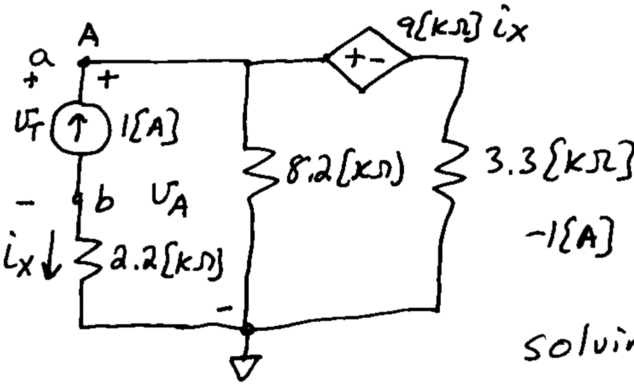
see next page

Solving, we get $v_C(0) = -9.15[V]$

Next, we redraw for $0 < t < 20[ms]$



There are no independent sources in the part of the circuit of interest. Thus we will have a natural response. We need τ, so we find R_{EQ} seen by the capacitor. We therefore remove the capacitor, set independent sources to zero (there are none), and apply a test source. Drawing this, we get



$i_x = -1[A]$

KCL yields:

$$-1[A] + \frac{v_A - 9[k\Omega]i_x}{3.3[k\Omega]} + \frac{v_A}{8.2[k\Omega]} = 0$$

solving, $v_A = -4064[V]$

Then KVL gives

$$v_T = v_A - i_x 2.2[k\Omega] = -1864[V]$$

$$R_{EQ} = v_T / 1[A] = -1.864[k\Omega]$$

$$\tau = R_{EQ} C_1 = -8.762[ms]$$

$$v_C(t) = (-9.15[V]\, e^{t/8.762[ms]}); \text{ for } 0 \le t \le 20[ms]$$

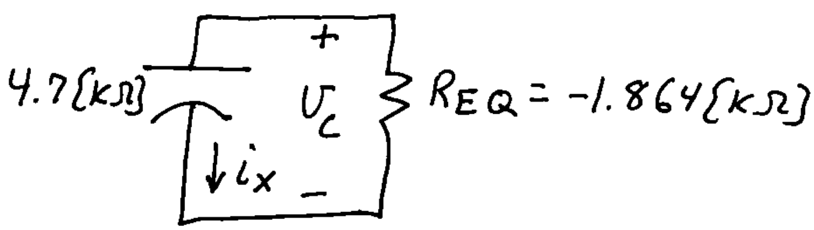
see next page

Now we are ready to find the requested values.

a) To get $i_x(0^-)$, we look at the diagram for $t<0$. As noted there,

$$\boxed{i_x(0^-) = 0}$$

b) To get $i_x(0^+)$, we have several choices. I will choose to redraw, using the R_{EQ} we found: for $0<t<20[ms]$



$$i_X = -\frac{v_C}{R_{EQ}} = \frac{v_C}{1.864[k\Omega]}$$

$$i_X(0^+) = \frac{v_C(0^+)}{1.864[k\Omega]} = \frac{-9.15[V]}{1.864[k\Omega]} = \boxed{-4.91[mA]}$$

c) $$i_X(10[ms]) = \frac{v_C(10[ms])}{1.864[k\Omega]} = (-4.91[mA])\, e^{(10/8.762)}$$

$$= \boxed{-15.37[mA]}$$