Name: ______________________________ (please print)

Signature: ____________________________

ECE 2300 – Quiz #5
April 15, 2013

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. **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.**
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.

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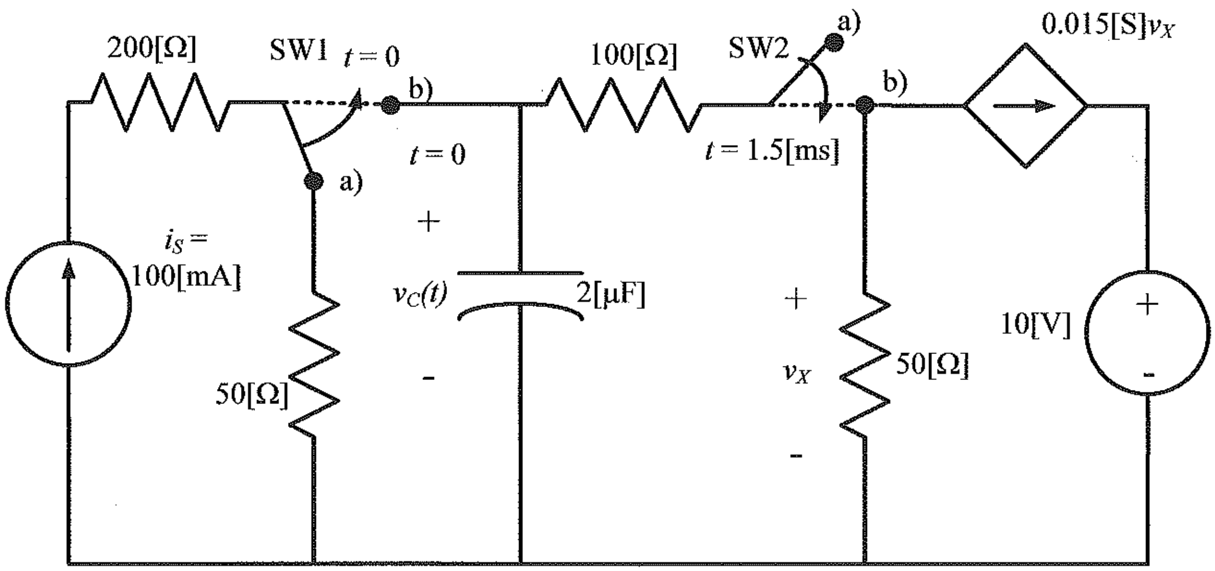
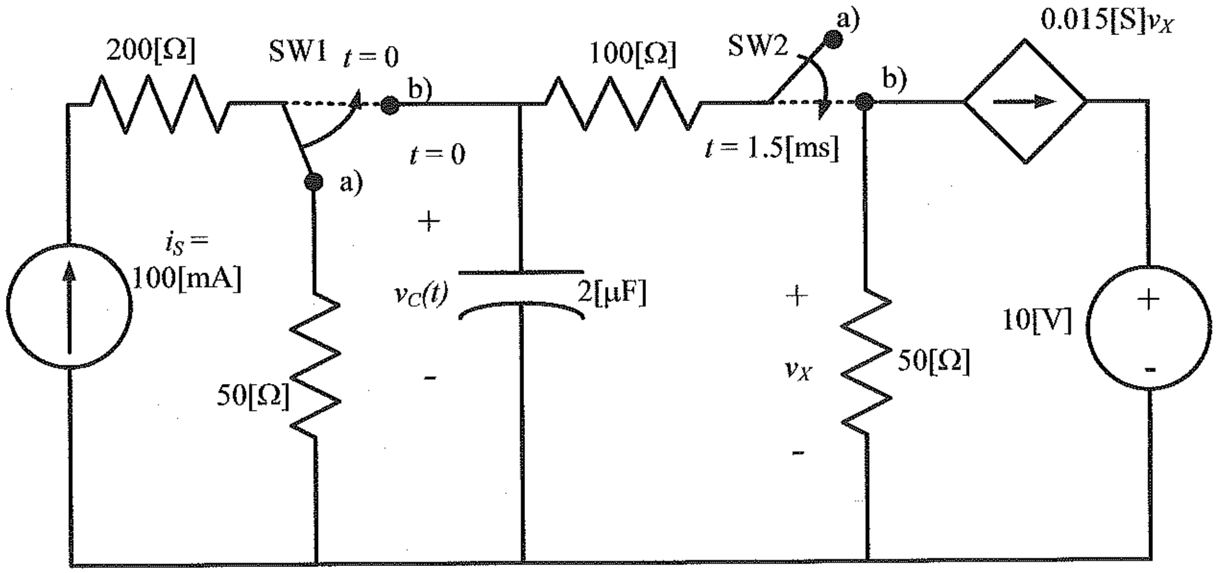
Switches 1 and 2 were in position a) for a long time before moving to position b) at the times indicated for each switch. Find the voltage $v_C(t)$ for $t \geq 0$.



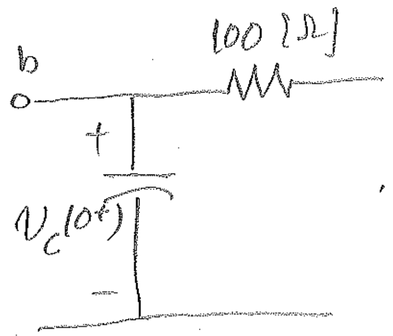
Room for extra work

Switches 1 and 2 were in position a) for a long time before moving to position b) at the times indicated for each switch. Find the voltage $v_C(t)$ for $t \geq 0$.



We begin by re-drawing the circuit for $t<0$.

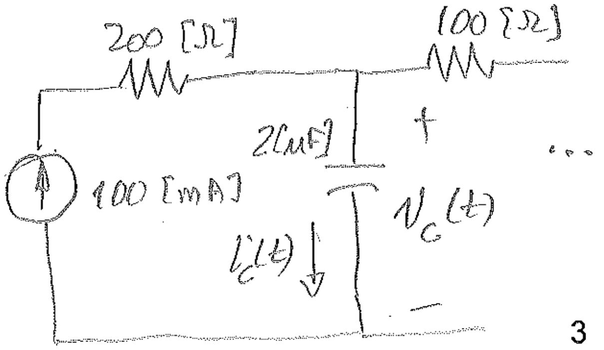
$t<0$



the rest of the circuit is not relevant for $t<0$. We have

$$v_C(0^-) = v_C(0^+) = 0$$

This is the initial condition for the first switching event. We now re-draw for $0 < t < 1.5$ [ms].



We have a current source in series with C. This is not a single-time constant problem...

to pg. 4

Room for extra work

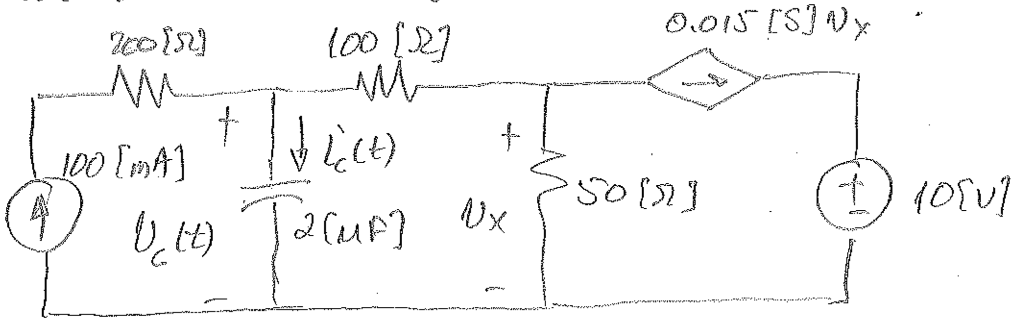
$$v_C(t) = \frac{1}{C}\int_0^t i_c(t)\,dt + v_C(0^+) = 5\times10^4\,t + 0\ [V]$$
$0 \le t \le 1.5\ [ms]$

$$v_C(t=1.5[ms]) = \frac{1}{2\times10^{-6}}\int_0^{0.0015\ [s]} 0.1\ [A]\ dt + 0$$

$$= 75\ [V] = v_C(1.5\ [ms]^+)$$

This is the initial condition for the second switching event at $t = 1.5$ [ms].

We now re-draw for $t > 1.5$ [ms].



We need i) the final value (at $t\to\infty$) of v_C and...
ii) R_{TH} seen by the capacitor.

$v_C(t\to\infty)$: $C \to$ open circuit so (node-voltage method)

$$\frac{v_X}{50} + 0.015\,v_X - 0.1 = 0 \qquad (i_c(t\to\infty) = 0)$$

$$\Rightarrow v_X = 2.857\ [V]$$

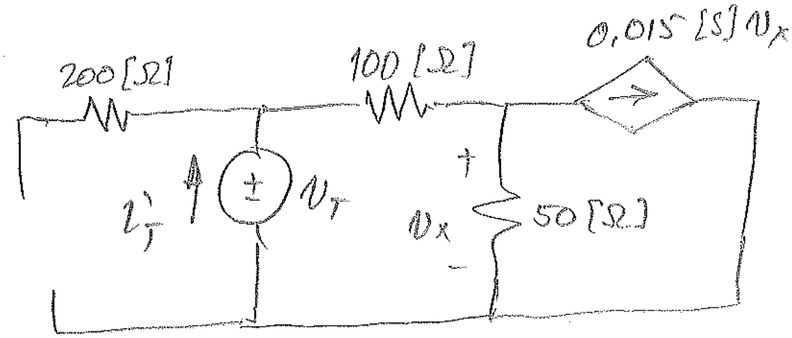
$$\therefore\ v_C(t\to\infty) = v_{C,f} = (0.1)(100) + v_X = 12.857\ [V]$$

This is the "final value".

→ pg. 2

Room for extra work

R_{TH} :



$$\frac{v_x}{50} + 0.015 v_x + \frac{v_x - 1}{100} = 0 \Rightarrow v_x = 0.2222 \text{ [V]}$$

$$i_T' = \frac{v_x}{50} + 0.015 v_x = 7.777 \times 10^{-3} \text{ [A]}$$

$$R_{TH} = 1/i_T' = 128.6 \text{ [Ω]} \qquad \tau = R_{TH} C = 0.2572 \text{ [ms]}$$

We now can put $v_c(t)$ together...

$$v_c(t) = 5 \times 10^4 t \text{ [V]} \qquad 0 \le t \le 1.5 \text{ [ms]}$$

$$v_c(t) = v_{c,f} + (v(1.5 \text{ [ms]})^+ - v_{c,f}) e^{-(t - 1.5 \text{ [ms]})/0.257 \text{ [ms]}}$$

$$= \left[12.86 + (75 - 12.86) e^{-(t - 1.5 \text{ [ms]})/0.257 \text{ [ms]})}\right] \text{ [V]}$$

$$v_c(t) = \left[12.86 + 62.14 e^{-(t - 1.5 \text{ [ms]})/0.257 \text{ [ms]})}\right] \text{ [V]} \quad t \ge 1.5 \text{ [ms]}$$

This is a long problem, which is why the time was extended to 40 min from the usual 30 min.