Name: _____ (please print)

Signature: _____

ECE 2202 – Exam 1

October 1, 2022

Keep this exam closed until you are told to begin.

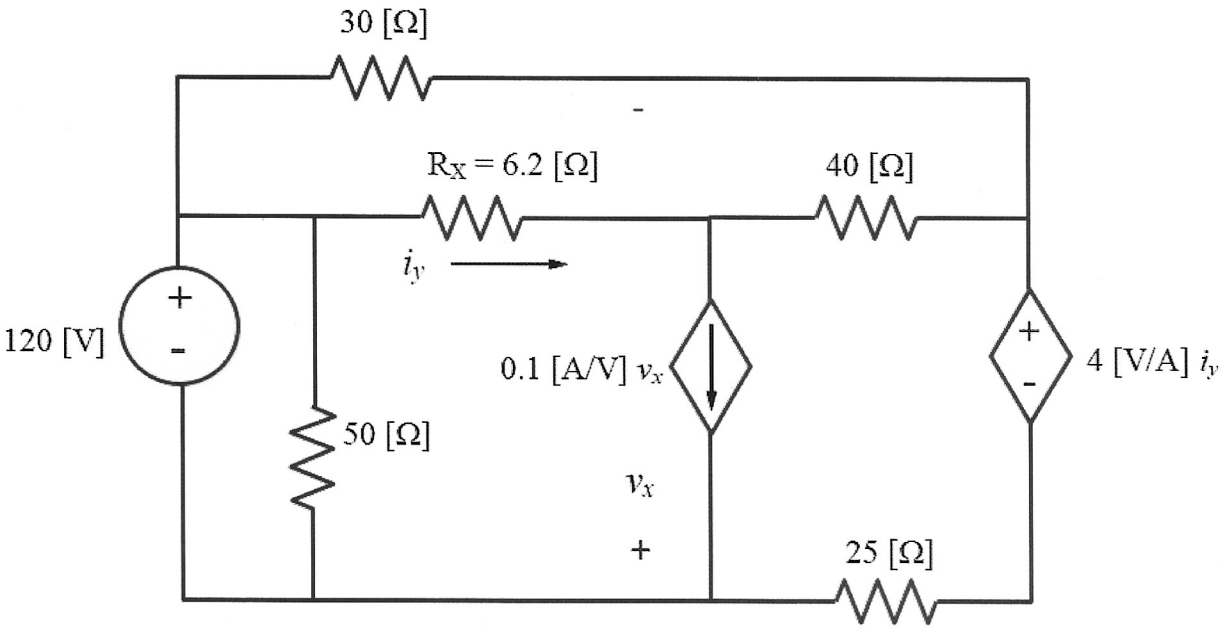
1. This exam is closed book, closed notes. You may use one 8.5" x 11" crib sheet, or its equivalent.
2. Show all work on these pages. Show all work necessary to complete the problem. A solution without the appropriate work shown will receive no credit. A solution that is not given in a reasonable order will lose credit. Clearly indicate your answer (for example by enclosing it in a box).
3. Show all units in solutions, intermediate results, and figures. Units in the exam will be included between square brackets.
4. If the grader has difficulty following your work because it is messy or disorganized, you will lose credit.
5. Do not use red ink. Do not use red pencil.
6. You will have 90 minutes to work on this exam.

1. _____/35
2. _____/30
3. _____/35

Total = 100

Room for extra work

1. {35 Points} For the circuit below, find the Thevenin equivalent seen by R_X. Draw and label the parameters of the Thevenin equivalent.

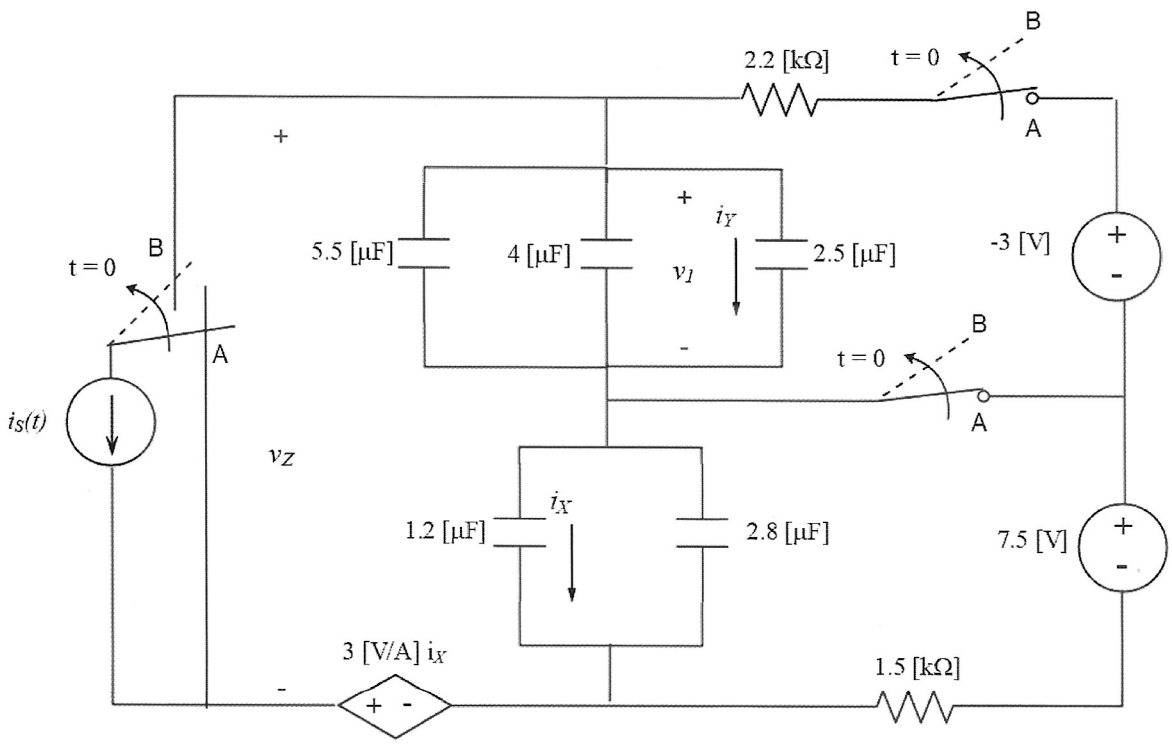


Room for extra work

2. {30 Points} In the circuit below, all three switches were in position 'A' for a long time. At t = 0, all three moved to position 'B'. The current source $i_S(t)$ is given by

$$i_S(t) = 2.5[\text{mA}]e^{-t/3[ms]} \quad t \geq 0 .$$

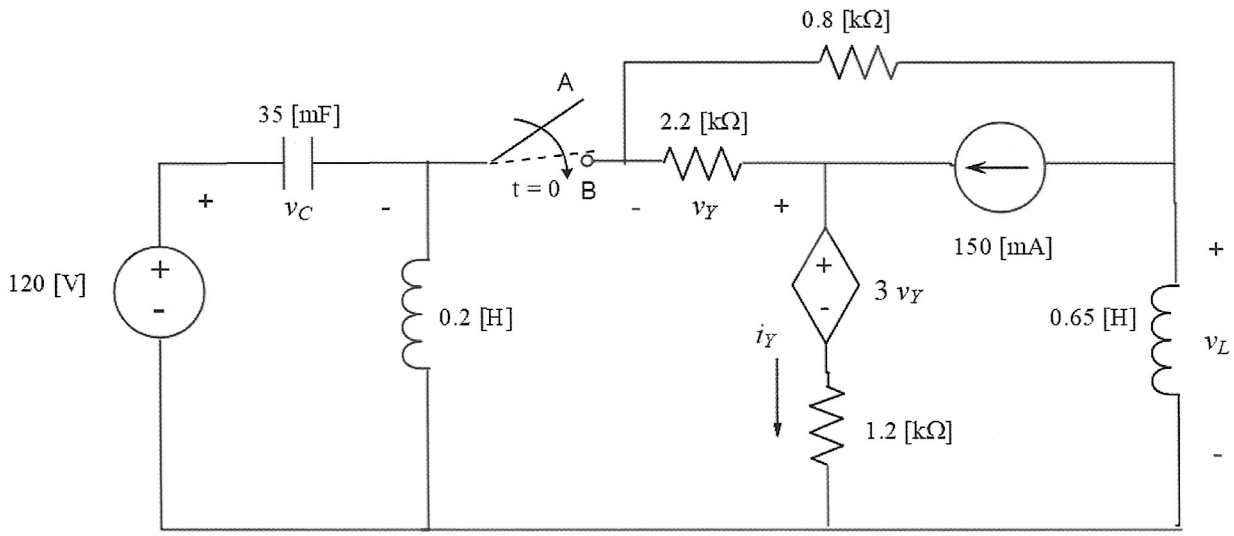
a) Find v_1 at t = 8 [ms].
b) Find i_X as a function of time for t > 0.
c) Find v_Z as a function of time for t > 0.



Room for extra work

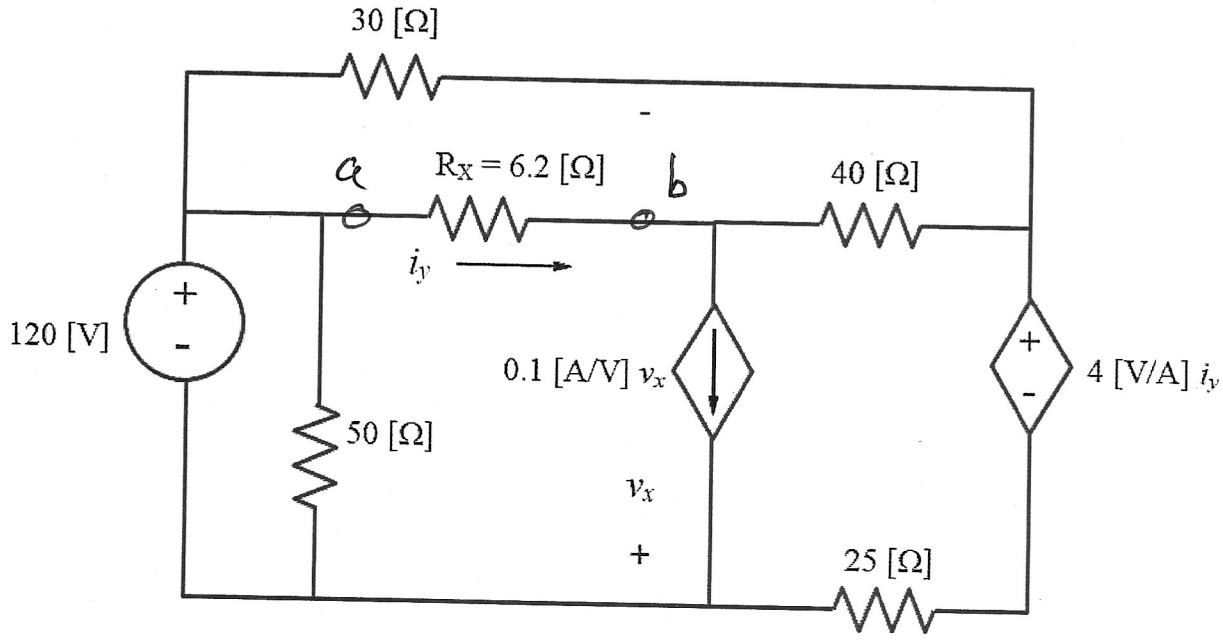
3. {35 Points} In the circuit below, the switch was in position 'A' for a long time, and then moved to position 'B' at t = 0.

a) Find $v_C(0^-)$.
b) Find $v_L(0^+)$.
c) Find $i_Y(0^+)$.



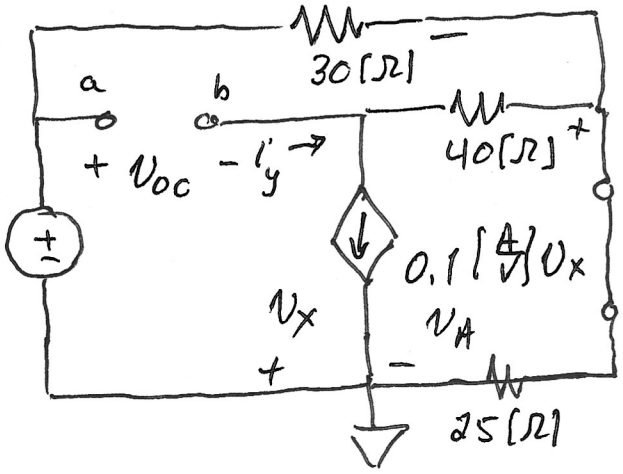
Room for extra work

1. {35 Points} For the circuit below, find the Thevenin equivalent seen by R_X. Draw and label the parameters of the Thevenin equivalent.



we need two of three things: open-circuit voltage v_{oc}, short-circuit current i_{sc}, test source for R_{TH}. we will do all three as a check.

we can ignore 50 [Ω] in parallel with 120 [V], and we remove R_X.



$i_y = 0 \Rightarrow 4\left[\frac{V}{A}\right] i_y = 0$ → short

$$\frac{v_A}{25} + \frac{v_A - 120}{30} + 0.1 v_x = 0$$

$$v_x = -v_A$$

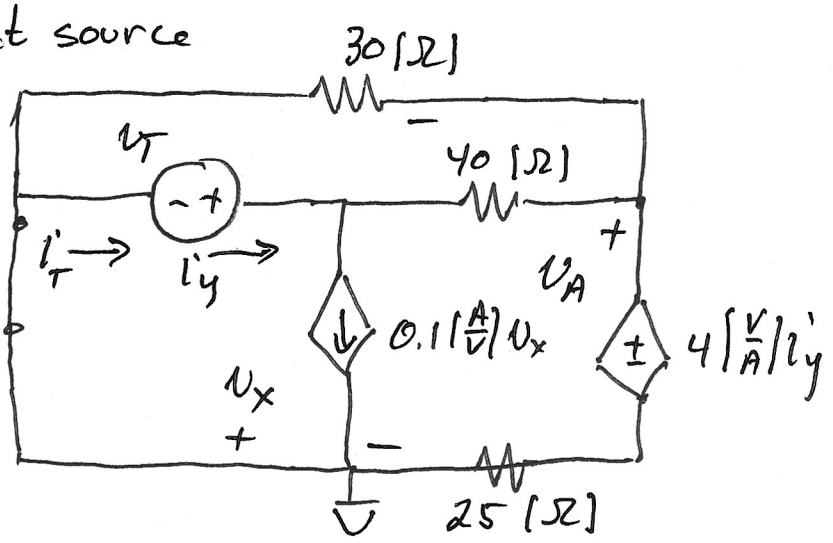
$$-v_{oc} + 120 - v_A + 40(0.1 v_x) = 0$$

$$v_A = 150 \text{ [V]}$$

$$\boxed{v_{oc} = 870 \text{ [V]} = v_{TH}}$$

Room for extra work

test source



$i'_y = i'_T$

$v_T \equiv 1\ [V]$

$$\frac{v_A - 4i'_T}{25} + \frac{v_A - 1}{40} + \frac{v_A}{30} = 0$$

$$i'_T = 0.1 v_x - \frac{v_A - 1}{40}$$

$v_x = -v_A$

$v_A = 0.2451\ [V] \quad i'_T = -5.6338\ [mA] \Rightarrow \boxed{R_{TH} = -177.5\ [\Omega]}$

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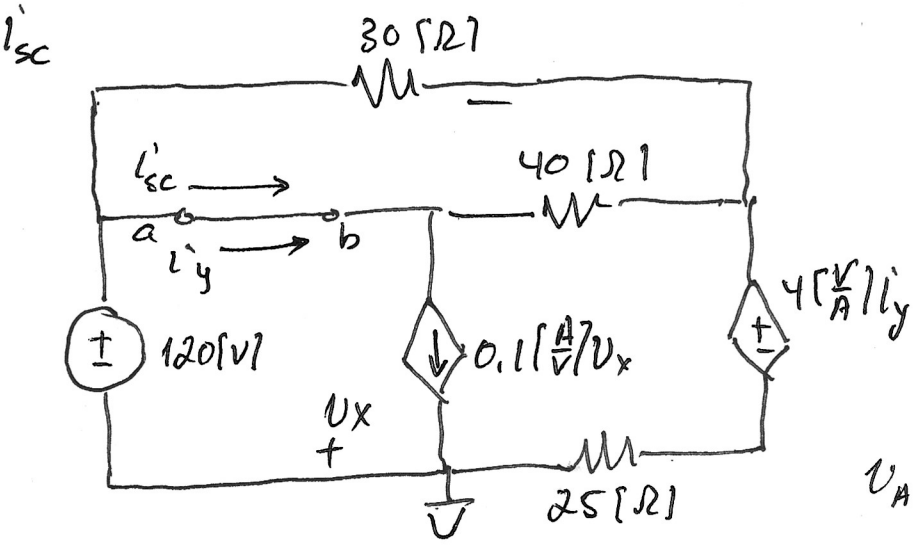
i'_{sc}



$i'_{sc} = i'_y$

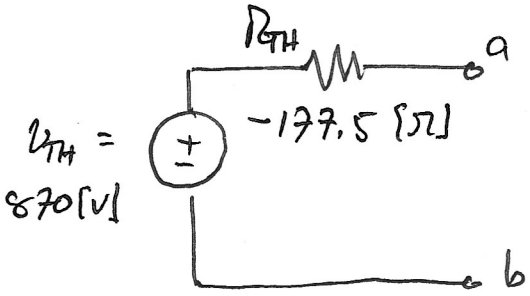
$$\frac{v_A - 4i'_y}{25} + \frac{v_A - 120}{30} + \frac{v_A - 120}{40} = 0$$

$$i'_y = 0.1 v_x - \frac{v_A - 120}{40}$$

$v_x = -v_A$

$v_A = 63.21\ [V] \quad i'_{sc} = -4.9014\ [A]$

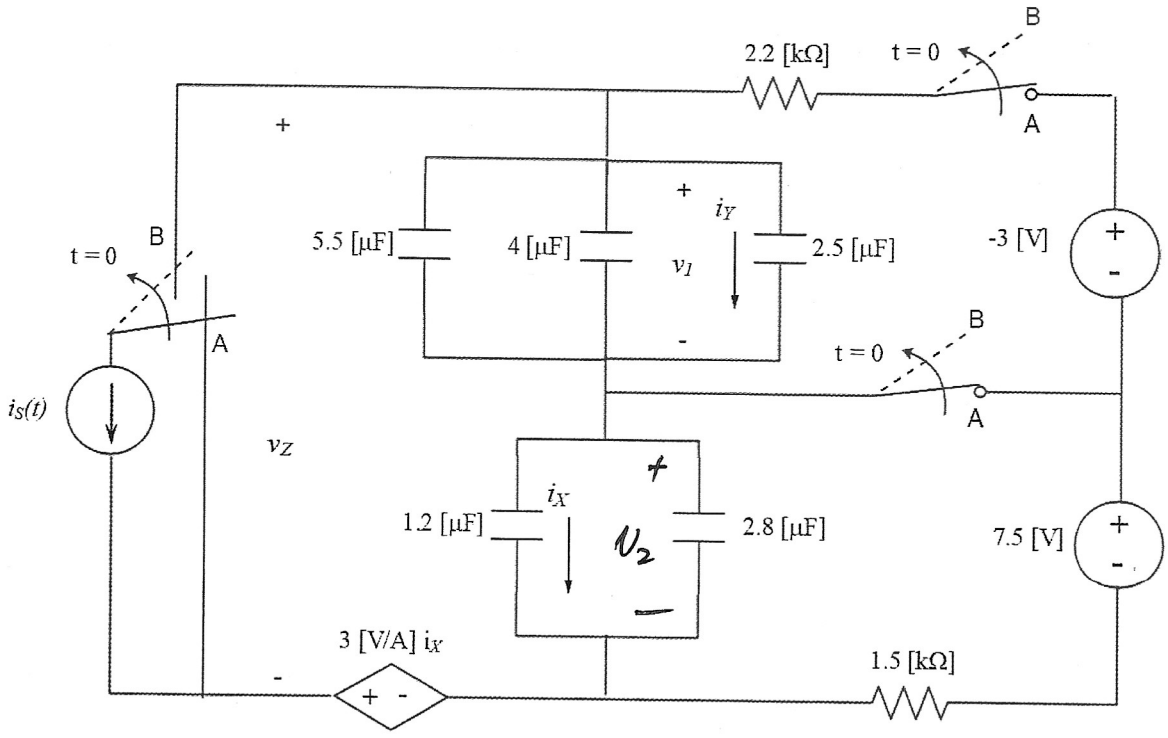
$R_{TH} = v_{oc}/i'_{sc} = \frac{870\ [V]}{-4.9014\ [A]} = -177.5\ [\Omega]$ so this checks.



2. {30 Points} In the circuit below, all three switches were in position 'A' for a long time. At t = 0, all three moved to position 'B'. The current source $i_S(t)$ is given by

$$i_S(t) = 2.5[\text{mA}]e^{-t/3[ms]} \quad t \geq 0 .$$

a) Find v_1 at t = 8 [ms].
b) Find i_X as a function of time for t > 0.
c) Find v_Z as a function of time for t > 0.



we draw the circuit for t<0:

Capacitors → open circuit

combine parallel capacitors

define v_2

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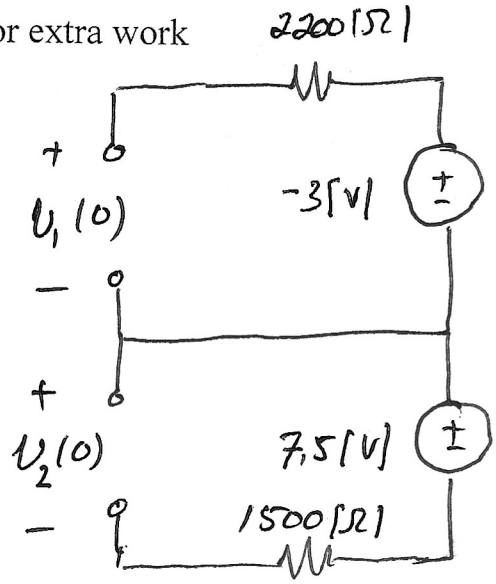
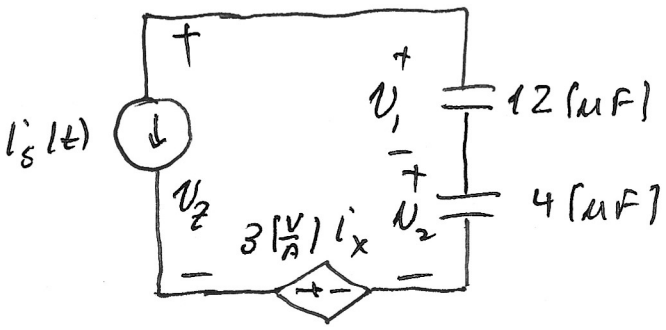
Room for extra work



$v_1(0) = -3\,[V]$

$v_2(0) = 7.5\,[V]$

Draw for $t > 0$



a) we don't need to worry about $3\left[\frac{V}{A}\right] i_x$ for part a) since it's in series with a current source.

$$v_1(t) = \frac{-1}{12\times10^{-6}} \int_0^t 0.025\,[A]\, e^{-t/0.003[s]}\, dt \quad - 3\,[V]$$

$$= 6.25\,[V]\left(e^{-t/0.003[s]} - 1\right) - 3\,[V]$$

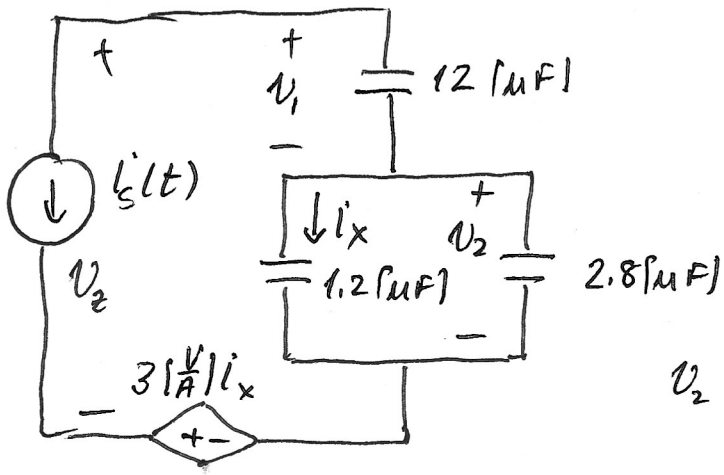
$$= 6.25\,[V]\, e^{-t/0.003[s]} - 9.25\,[V] \qquad t \geq 0$$

$$v_1(t = 8\,[ms]) = 6.25\, e^{-8/3} - 9.25 = -8.8157\,[V]$$

pg. 2

Room for extra work

b)



From previous diagram:

$$v_2(t) = \frac{-1}{4\times10^{-6}} \int_0^t 0.025\, e^{-t/0.003\,[s]}\, dt + 7.5\,[V]$$

$$v_2(t) = 18.75\,[V]\, e^{-t/0.003\,[s]} - 11.25\,[V]$$

$$i_x(t) = 1.2\times10^{-6} \frac{dv_2(t)}{dt} = -7.5\,[mA]\, e^{-t/0.003\,[s]} \qquad t > 0$$

c)

$$v_z(t) = v_1(t) + v_2(t) - 3\left[\frac{V}{A}\right] i_x(t)$$

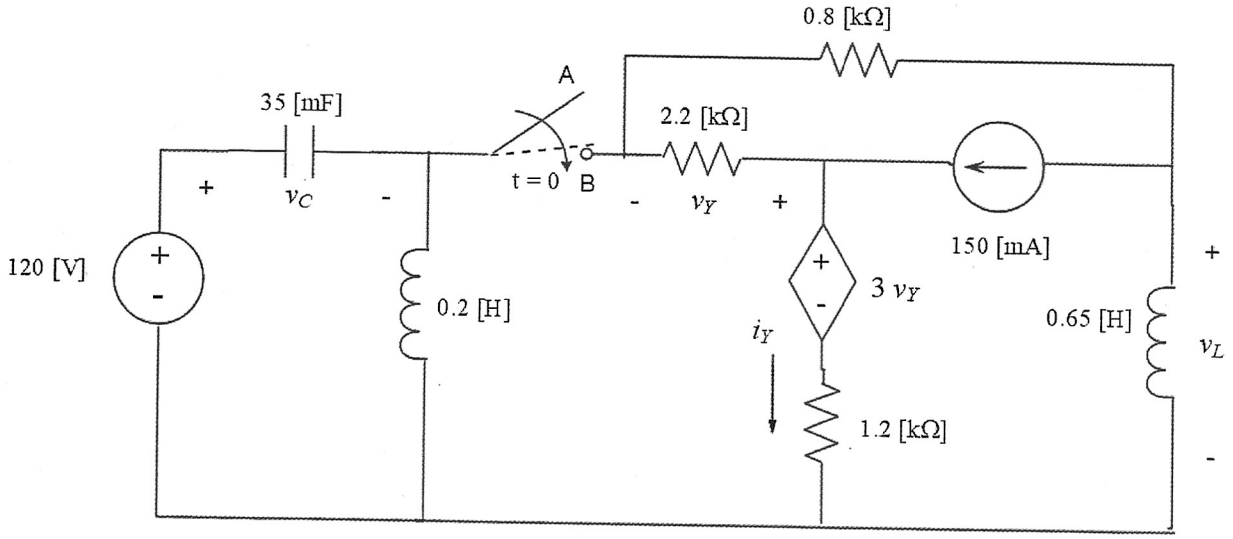
$$= \left(6.25\,[V]\, e^{-t/0.003\,[s]} - 9.25\,[V]\right) + \left(18.75\,[V]\, e^{-t/0.003\,[s]} - 11.25\,[V]\right)$$

$$- 3\,[-0.0075]\,[V]\, e^{-t/0.003\,[s]}$$

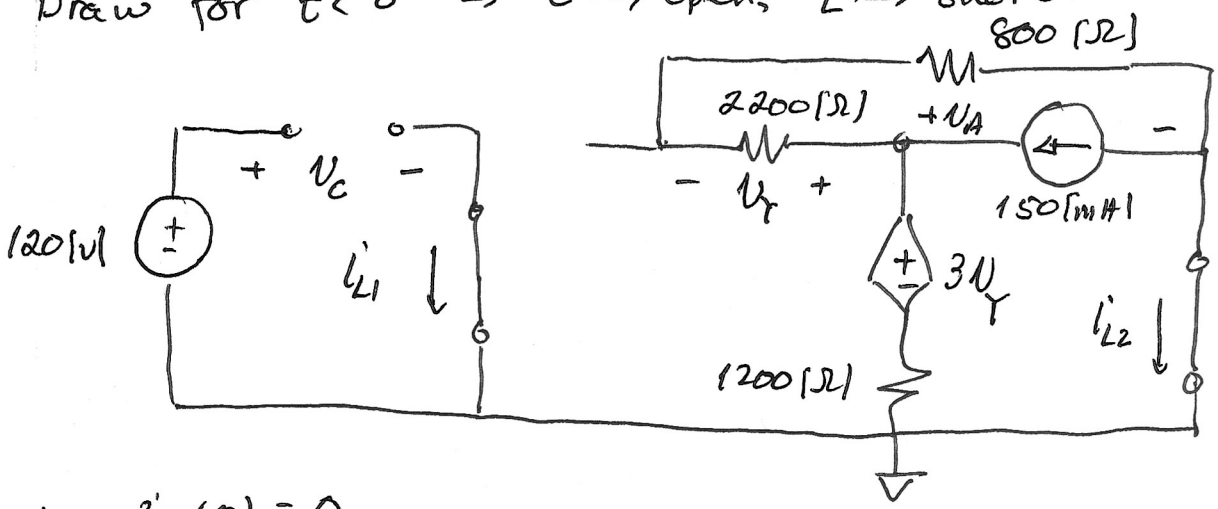
$$v_z(t) = 24.98\, e^{-t/0.003\,[s]} - 20.5 \quad [V]$$

3. {35 Points} In the circuit below, the switch was in position 'A' for a long time, and then moved to position 'B' at t = 0.

a) Find $v_C(0^-)$.
b) Find $v_L(0^+)$.
c) Find $i_Y(0^+)$.



Draw for $t<0$ → C → open, L → short.



$i_{L_1}(0) = 0$

$v_C(0) = 120\,[V]$

$i_{L_2}(0) = -75.0\,[mA]$

$v_A = 225\,[V]$ $v_Y = 165\,[V]$

$$\frac{v_A - 3v_Y}{1200} - 0.150 + \frac{v_A}{3000} = 0$$

$$v_Y = v_A \cdot \frac{2200}{3000}$$

$$i_{L_2}(0) + 0.150 - \frac{v_A}{3000} = 0$$

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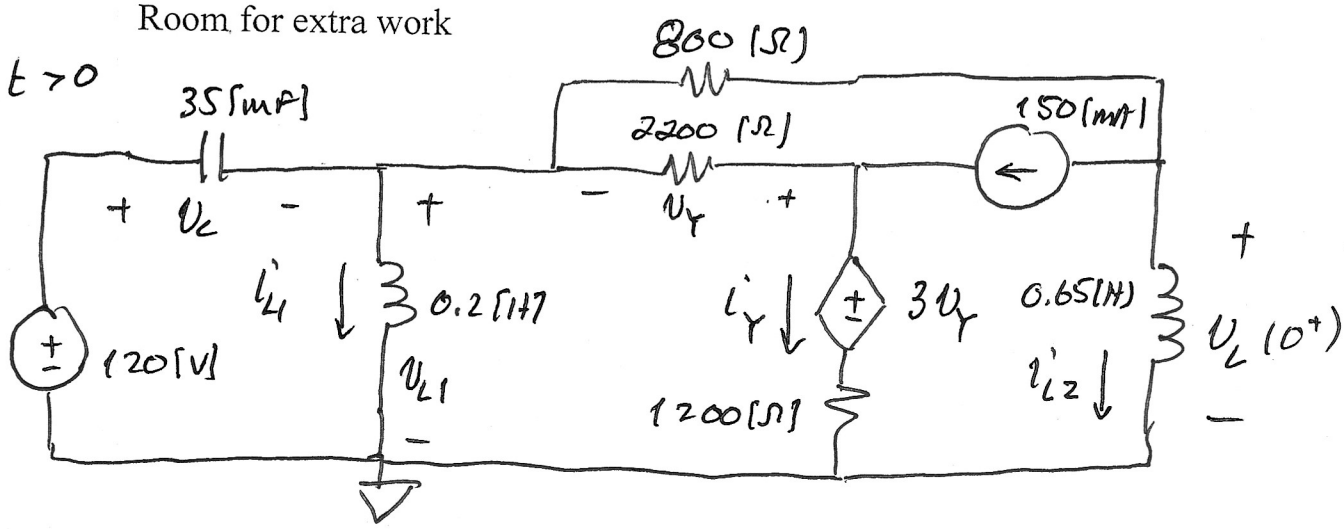
Room for extra work



$v_c(0^+) = v_c(0) = 120\ [V]$ $\quad i_{L1}(0^+) = i_{L1}(0) = 0$

so $v_{L1} = 120 - v_c = 0$

$$\frac{v_Y - 3v_Y}{1200} + \frac{v_Y}{2200} - 0.150 = 0 \Rightarrow v_Y = -123.75\ [V]$$

$$v_L(0^+) + 800\,(i_{L2}(0^+) + 0.150 = 0 \Rightarrow \boxed{v_L(0^+) = -60\ [V]}$$

$$\boxed{i_Y(0^+) = \frac{v_Y - 3v_Y}{1200} = 206.25\ [mA]}$$