Name: _____ (please print)

Signature: _____

ECE 2300 – Quiz #5
July 14, 2016

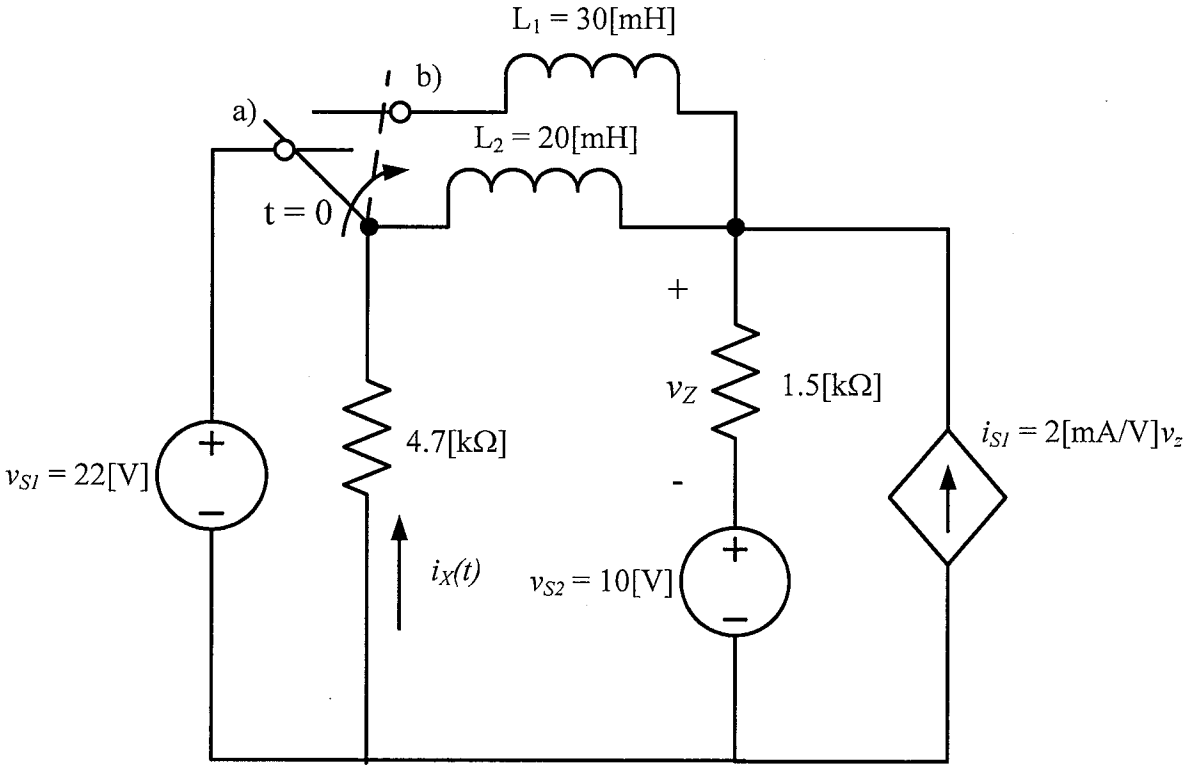
Keep this quiz closed and face up until you are told to begin.

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. Show all units in solutions, intermediate results, and figures. Units in the quiz 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 40 minutes to work on this quiz.

_____/40

Room for extra work

In the circuit below, the switch was in position a) for a long time, and then moved to b) at t = 0. Find $i_x(t)$ for t > 0.



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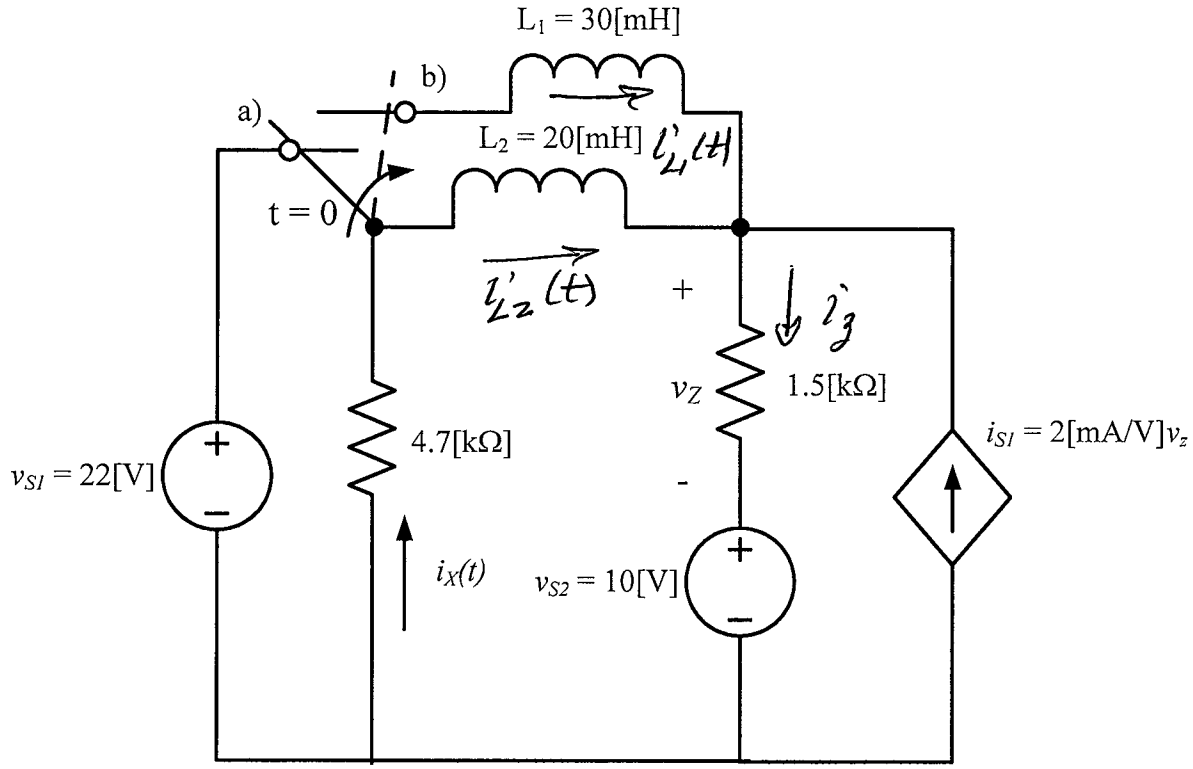
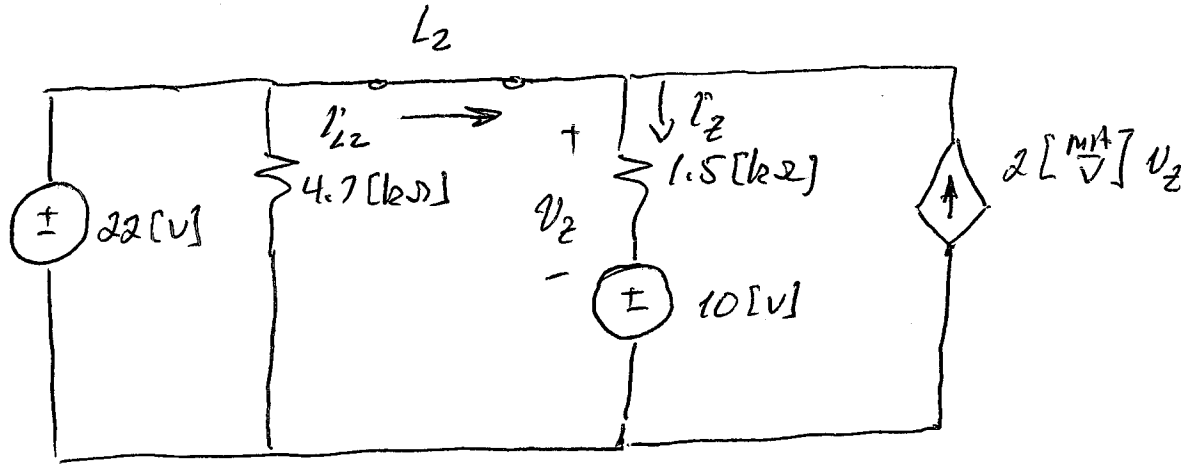


For $t<0$, both inductors are a short. We need initial conditions. Clearly $i_{L_1}(0) = 0$. So for L_2: +2



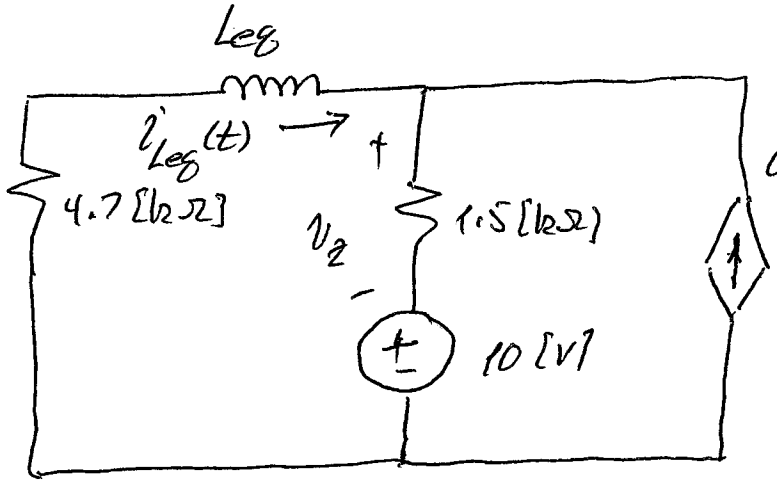
$$i_2 = \frac{22-10}{1500} = 8\,[mA] \qquad v_z = 12\,[V]$$

$$\therefore\ i'_{L_2}(0) = i_2 - 0.002(12) = -16\,[mA]$$

+4

Room for extra work

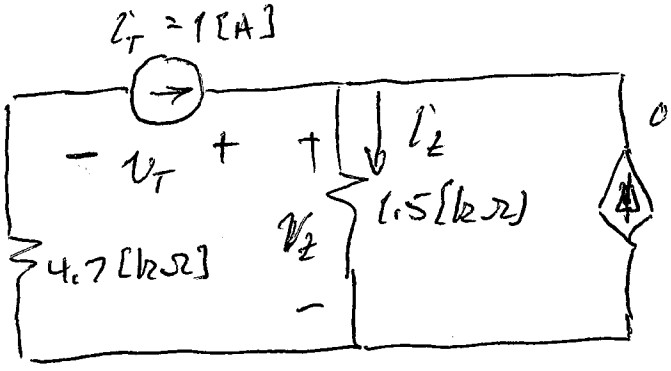
We now re-draw for $t>0$. Source V_{S1} is now out of play, and we can combine the inductors in parallel.



$L_{eq} = L_1 \| L_2 = 12\ [mH]$ +2

$i_{Leq}(0) = i_{L1}(0) + i_{L2}(0) = 0 - 16\ [mA] = -16\ [mA]$ +3

We need the equivalent resistance seen by the inductor, so we remove it and replace with a test source.



$i_z = 1 + 0.002(1500\, i_z)$

$\Rightarrow i_z = -0.5$ [A]

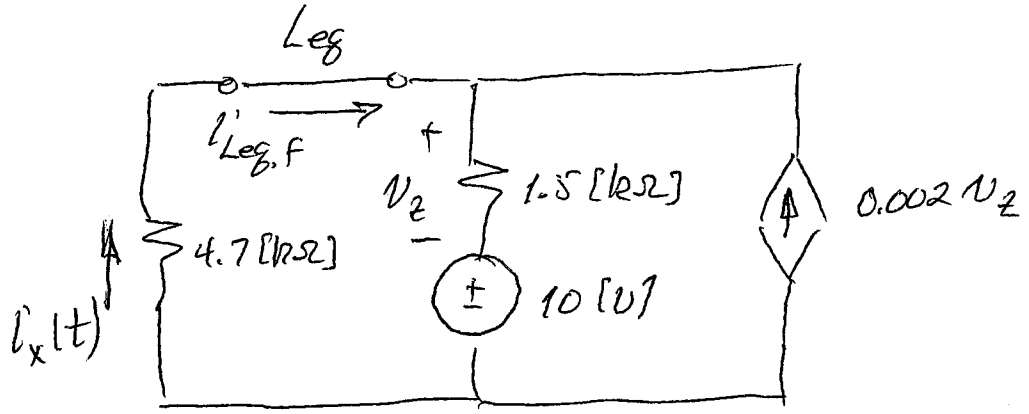
$-v_T + 1500(-0.5) + 4700(1) = 0$

$v_T = 3950$ [V] $\Rightarrow R_{Th} = 3950$ [Ω] +9

Time Constant: $\tau = L_{eq}/R_{Th} = \frac{12\times10^{-3}}{3950} = 3.04$ [μs] +3

Room for extra work

We also need the final (steady-state) value of i'_{Leq}, so we replace Leq with a short:



$$\frac{v_z}{1500} + \frac{v_z + 10}{4700} - 0.002\, v_z = 0 \Rightarrow v_z = 1.8987\ [V]$$

$$i'_{Leq,f} = -\frac{v_z + 10}{4700} = -2.53\ [mA] \quad +9$$

So $$i'_{Leq}(t) = -2.53 + (-16.00 + 2.53)\, e^{-t/3.04\,[\mu s]} \quad [mA]\ (+2) \quad +6$$

$$t \geq 0\ [\mu s]\ (+1)$$

Finally $$i_x(t) = i'_{Leq}(t) = -2.53 - 13.47\, e^{-t/3.04\,[\mu s]} \quad [mA]$$

$$t > 0\ [\mu s] \quad +2$$