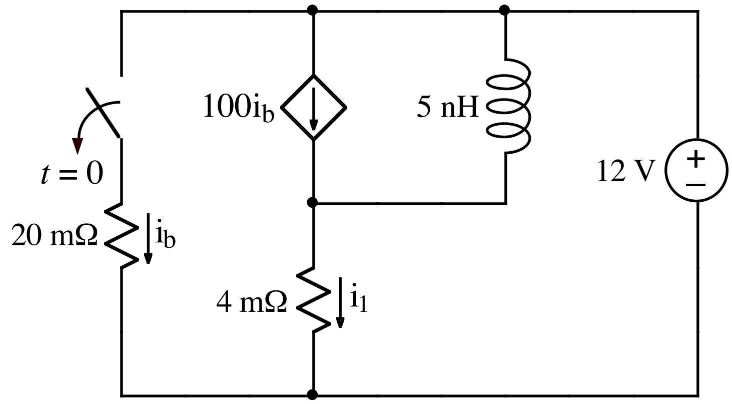
HOMEWORK #11 solution

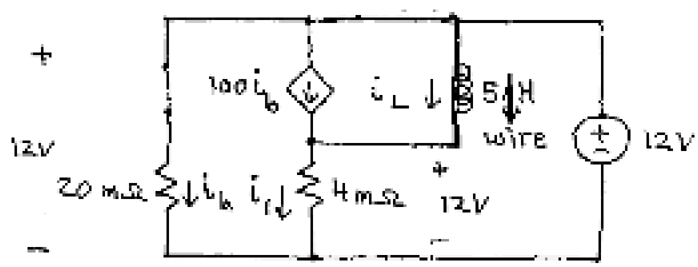
THE UNIVERSITY OF UTAH

Ex:



After being closed for a long time, the switch opens at $t = 0$. Find $i_1(t)$ for $t > 0$.

sol'n: $t = 0^-$ model: (to find $i_L(0^-)$) L acts like wire



We see that the 12V source is across the 20 mΩ and the 4 mΩ.

$$\therefore\ i_b = \frac{12\text{V}}{20\text{m}\Omega} = 600\text{ A}$$

and $100\, i_b = 100 \cdot 600\text{A} = 60\text{ kA}$.

$$i_1 = \frac{12\text{V}}{4\text{m}\Omega} = 3\text{kA}$$

We find i_L from a current sum at the center node.

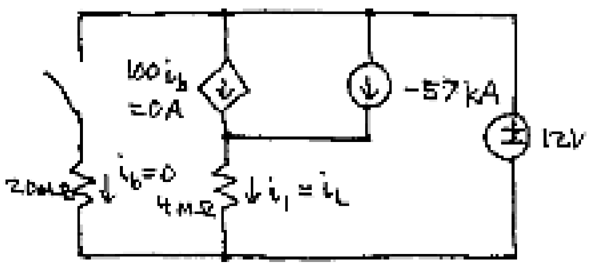
$$-100 i_b + i_1 - i_L(0^-) = 0\ A$$

$$-60\,kA + 3\,kA = i_L(0^-)$$

or $i_L(0^-) = -57\,kA$

$t = 0^+$ model: $i_L(0^+) = i_L(0^-) = -57\,kA$

L modeled as current source

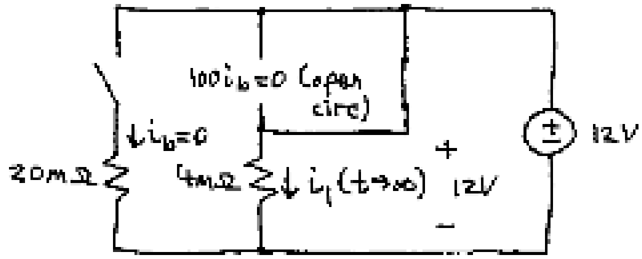


Because of the open circuit on the left, we have $i_b = 0$ and $100 i_b = 0$.

From a current summation at the center node, we have $i_1(0^+) = i_L(0^+) = -57kA$.

$$i_1(0^+) = -57\,kA$$

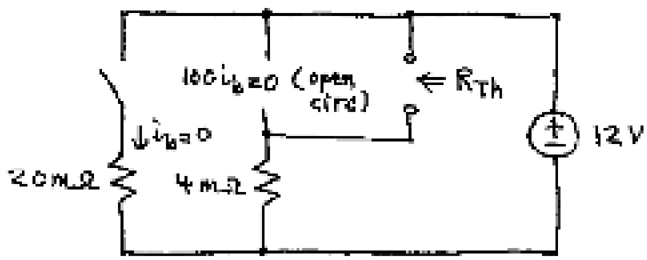
$t \to \infty$ model: (to find $i_1(t \to \infty)$) L acts like wire



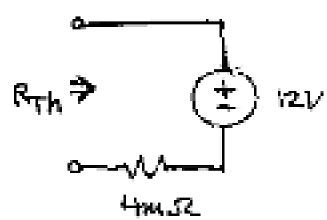
We have 12V across the 4 mΩ.

$$i_1(t\to\infty) = \frac{12V}{4\,m\Omega} = 3\,kA$$

model for $\tau = L/R_{Th}$:



We observe that the Thevenin equivalent seen from the terminals where the L is connected is just the 4mΩ and 12V:



We find R_{Th} by turning off the 12V source, causing it to be a wire. We see R_{Th} = 4 mΩ. (The circuit is already a Thevenin equivalent.)

$$\therefore\ \tau = \frac{L}{R_{Th}} = \frac{5\,nH}{4\,m\Omega} = 1.2\,\mu s$$

Now we use the general form of solution:

$$i_1(t) = i_1(t\to\infty) + \left[i_1(0^+) - i_1(t\to\infty)\right] e^{-t/\tau}$$

or $$i_1(t) = 3kA + \left[-57kA - 3kA\right] e^{-t/1.2\mu s}$$

or $$i_1(t) = 3kA + -60kA\, e^{-t/1.2\mu s}$$