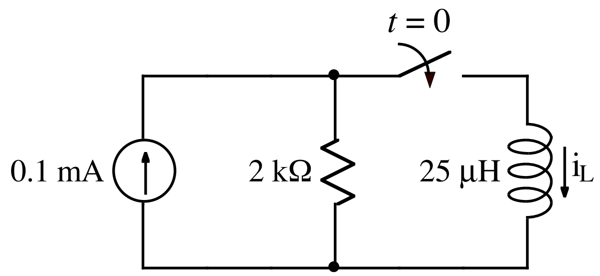
HOMEWORK #11 prob 2 solution

Ex:



After being open for a long time, the switch closes at $t = 0$. $i_L(t = 0^-) = 0$A. Find $i_L(t)$ for $t > 0$.

sol'n: Since i_L is an energy variable, it cannot change instantly.

$$\therefore \; i_L(t=0^+) = i_L(t=0^-) = 0 \text{ A}$$

This is one of the values we need for the general solution that describes $i_L(t)$:

$$i_L(t) = i_L(t\to\infty) + [i_L(t=0^+) - i_L(t\to\infty)]\, e^{-t/\tau}$$

where $\tau = L / R_{Th}$.

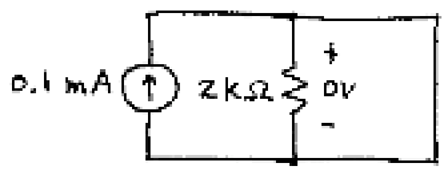
Note: R_{Th} is the Thevenin equivalent resistance seen looking into the terminals where L is connected. Since the circuit seen looking into the terminals is a Norton equivalent, and $R_N = R_{Th}$, we have

$$R_{Th} = 2\text{K}\Omega \quad \text{and} \quad \tau = \frac{25\,\mu\text{H}}{2\text{ K}\Omega} = 12.5 \text{ ns}$$

The value we lack for a complete sol'n is $i_L(t\to\infty)$. To find this value, we employ the idea that, as $t \to \infty$, the currents and voltages become constant, we have $v_L = L \frac{di}{dt} = L \cdot 0 = 0\,V$.

Thus, the L acts like a wire.

$t \to \infty$ model:



L acts like wire

Since the 2kΩ resistor is shorted out, it has 0V across, meaning that the current in the 2kΩ is $0V/2k\Omega = 0\,A$.

∴ All the 0.1 mA from the source flows thru the L.

Thus, $i_L(t \to \infty) = 0.1\,mA$.

Plugging values into the general sol'n yields

$$i_L(t) = 0.1\,mA + [0 - 0.1\,mA]\,e^{-t/12.5\,ns}$$

or $$i_L(t) = 0.1\,mA\left[1 - e^{-t/12.5\,ns}\right]$$