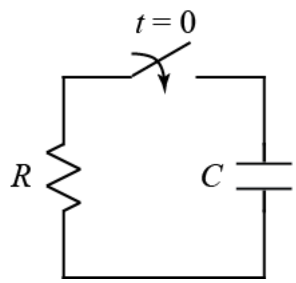
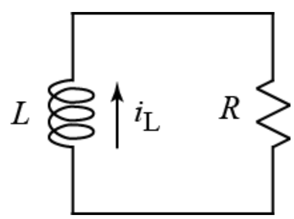
Homework 8

1. Find the an expression for the voltage, $v_C(t)$, across the capacitor in the circuit below for $t > 0$ if $R = 5\ \text{k}\Omega$, $C = 2\ \mu\text{F}$, and $v_C(t = 0) = 8$ V (with + sign of v measurement on top side of C). Note that the switch closes at time $t = 0$.



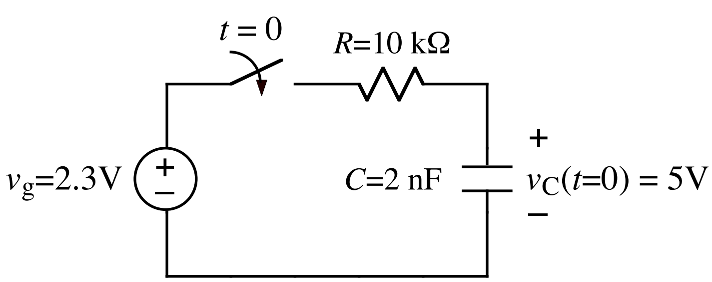
2.



a) Write a differential equation for the above circuit in terms of variable i_L. Hint: use a v-loop.

b) Find an expression for the current, $i_L(t)$, through the inductor in the circuit for $t > 0$ if $R = 5\ \text{k}\Omega$, $L = 2\ \mu\text{H}$, and $i_L(t = 0) = 8$ A.

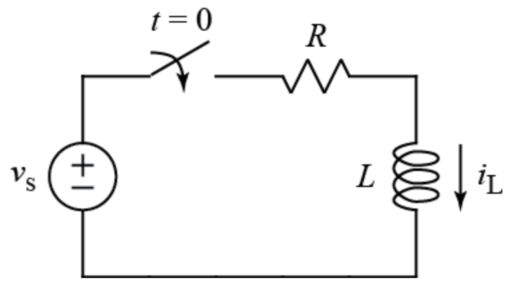
3. After being open for a long time, the switch closes at $t = 0$.



a) Find an expression for $v_C(t)$ for $t \geq 0$.

b) Find the energy stored in the capacitor at time $t = 30\ \mu\text{s}$.

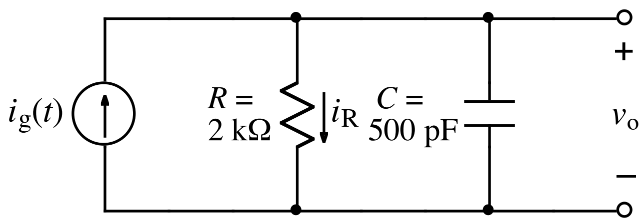
4. In the circuit below, the switch closes at $t = 0$ s, $v_s = 2.3$ V, $R = 10$ kΩ, $L = 2$ nH, and $i_L(t = 0) = 5$ A (arising from additional circuitry not shown that is disconnected at time $t = 0$ s).



a) Find an expression for $i_L(t)$ for $t \geq 0$.

b) Find the energy stored in the inductor at time $t = 30$ μs.

5. After being zero for a long time, the value of $i_g(t)$ changes to 15 mA at $t = 0$ (and remains at 15 mA as time increases to infinity).



a) Find an expression for $v_o(t)$ for $t > 0$.

b) Find the current, i_R, in R as a function of time.

Answers:

1. $v_C(t > 0) = 8\,\text{V}\,e^{-t/10\,\text{ms}}$

2.a) $L\dfrac{di_L(t)}{dt} + ? = 0\,\text{V}$ b) $i_L(t > 0) = 8\,\text{A}\,e^{-t/0.4\,\text{ns}}$

3.a) $v_C(t) = 2.3 + 2.7e^{\frac{-t}{20\,\mu\text{s}}}\,\text{V}$ b) $w_C = 8.42\,\text{nJ}$

4.a) $i_L(t \geq 0) = 0.23\,\text{mA} + (5\,\text{A} - 0.23\,\text{mA})\cdot e^{-t/0.2\,\text{ps}}$ b) Hint: $w_L = \dfrac{1}{2}Li_L^2$

5.a) Hint: the C looks like an open at time $t = 0^-$. b) $i_R(t \geq 0) = 15\,\text{mA} - 15\,\text{mA}\cdot e^{-t/1\,\mu\text{s}}$