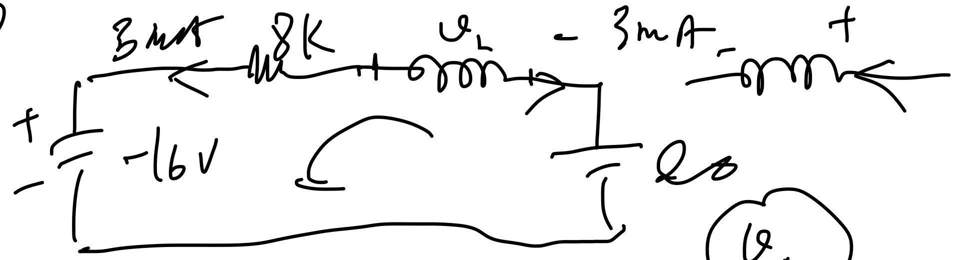
$-20 + v_L + 8i - 16 = 0$



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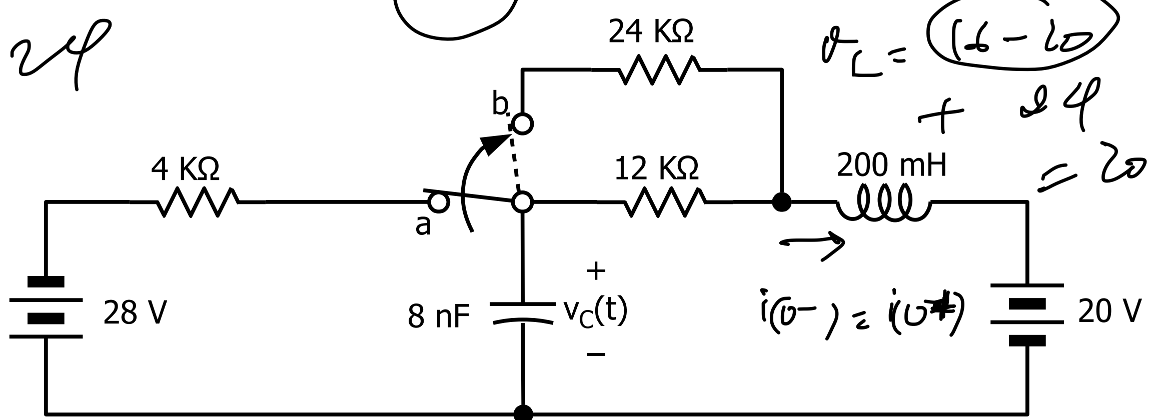
$v_L = 36 - 24 = 12$ V

$+16 + 8K(-3\,mA) + v_L + 20V = 0$

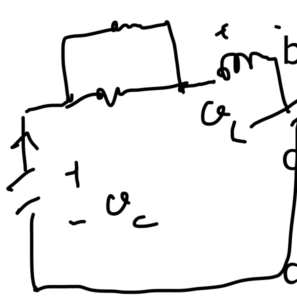
$-36 + 24$

$v_L = (16 - 20) + 24 = 20$ V



1. The switch has been in position a for a long time. All transients have died out. At t = 0, the switch moves instantaneously to position b.

   a. At t=0⁻ (the last instant that the switch is in position a), what is the current through the capacitor? $i = 0$



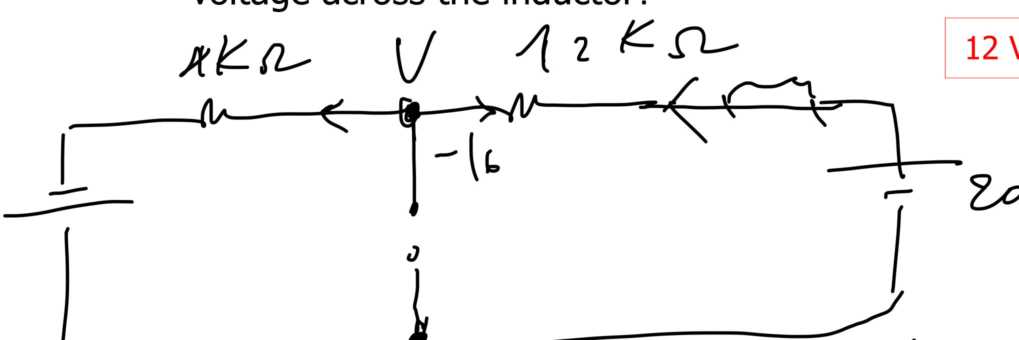
   b. At t=0⁻ (the last instant that the switch is in position a), what is the voltage across the capacitor? −16 V

   c. At t=0⁺ (the first instant that the switch is in position b), the current through the capacitor is the same as in Part a. True **False**

   d. At t=0⁺ (the first instant that the switch is in position b), the voltage across the inductor is the same as at t=0⁻. True **False**

   e. At t=0⁺ (the first instant that the switch is in position b), what is the voltage across the inductor?

12 V; + at right end



$$\frac{-16 - 20}{12\,K\Omega}$$

$$\frac{3V + 28\times 3}{3\times 4k} + \frac{V - 20}{12k} = 0 \Rightarrow 4V = 20 - 28\times 3 \Rightarrow \boxed{V = -16\,V}$$

$V_C = V_L = L\frac{di}{dt} = i_R R = (-i_C - i_L) R$

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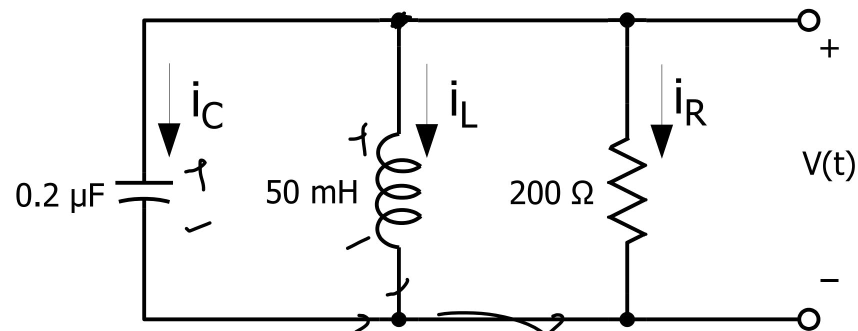
$V_C = 12$



2. This is a second-order circuit. There is an initial voltage on the capacitor $v(0^-)=12$ V, and an initial current in the inductor $i_L(0^-)=30$ mA. In order to solve the differential equation for v(t), the following values must be found:
   a. $i_C(0^+)$
   b. $i_R(0^+)$
   c. $dv(t)/dt|_{t=0^+}$

$t \to 0^+ \Rightarrow v(0^+) = 12V$

$t \to 0^+ \Rightarrow i_c(0^+) = 30mA$.

Using what you know about inductors, capacitors, and KCL, find these values.

a. −90 mA
b. 60 mA
c. −450 KV/s

$v = L\frac{di}{dt}$

$\int \frac{v\,dt}{L} = i$

$\frac{12V}{200} + i_L + i_C = 0$

$60mA + 30mA + i_C = 0$

$\Rightarrow i_C = -90mA$

$i_C + i_L + i_R = 0$

$C\frac{dv}{dt} + i_L + \frac{v}{R} = 0$

$V_C = V_L = L\frac{di}{dt}$

$L\frac{di_L}{dt} = (-i_C - i_L)R = -i_C R - i_L R = -RC\frac{dv}{dt} - i_L R$

$L\frac{di_L}{dt} + RC\frac{dv}{dt} + i_L R = 0$

$+RCL\frac{d^2 i}{dt^2} + L\frac{di_L}{dt} + i_L R = 0$

$v = L\frac{di}{dt}$

$\frac{dv}{dt} = L\frac{d^2 i}{dt^2}$

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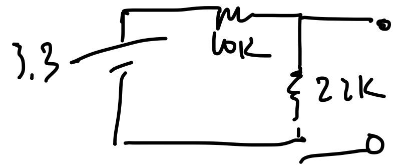


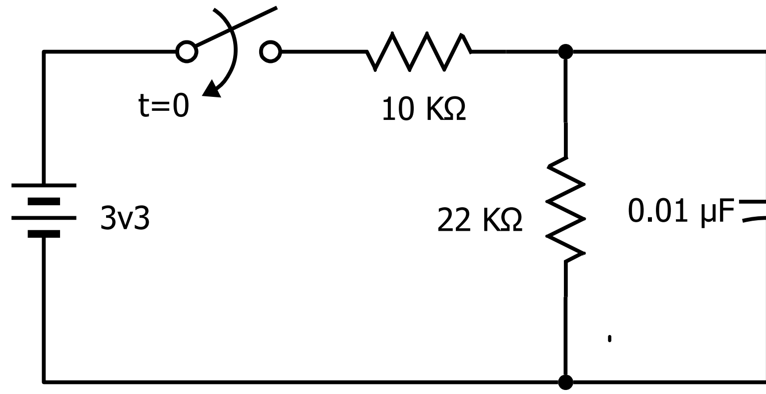
$V_{Th} = \frac{3.3}{32k} \cdot 22k$

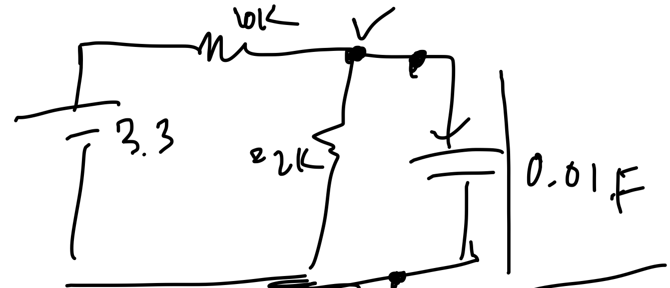
$R_{Th} = \frac{10k \times 22k}{10+22}$

3a. Find the time constant τ of this circuit. This will require solving the differential equation for the circuit.

3b. Then, find only the Thévenin resistance R_{th} of the circuit to the left of the capacitor (consider the capacitor to be the load).

3c. Then, compute R_{th}*C and compare to the τ from 3a.



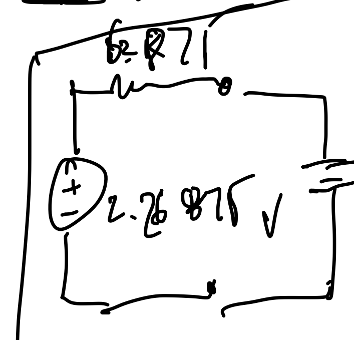


Time constant $\tau = 6.875\text{e-}5$ s

$R_{th} \cdot C = 6.875\text{e-}5$ s

$t = 0^- \Rightarrow v_c = 0$

$t = 0^+ \Rightarrow v_c = 0$



(E) $\frac{V - 3.3}{10\,000} + \frac{V}{22000} + i_c = 0$

$+ C\frac{dv}{dt} = 0$

$\frac{2.2(v - 3.3)}{2.2 \times 10k} + \frac{v}{22k} + C\frac{dv}{dt} = 0$

$R = 22K$

$3.2v - 7.26\,V + RC\frac{dv}{dt} = 0$

$RC\frac{dv}{dt} = 7.26V - 3.2v$

$\frac{dv}{7.26 - 3.2v} = \frac{dt}{RC}$

$\frac{dv}{\frac{3.2v - 7.26}{3.2}} = \frac{-dt}{\frac{RC}{3.2}}$

$\frac{dv}{v - 2.26875} = \frac{-dt}{RC/3.2}$

$\Rightarrow \tau = \frac{RC}{3.2} = \frac{22 \times 1000 \times 0.01 \times 10^{-6}}{3.2}$

$= 6.875 \times 10^{-5}$ (s)

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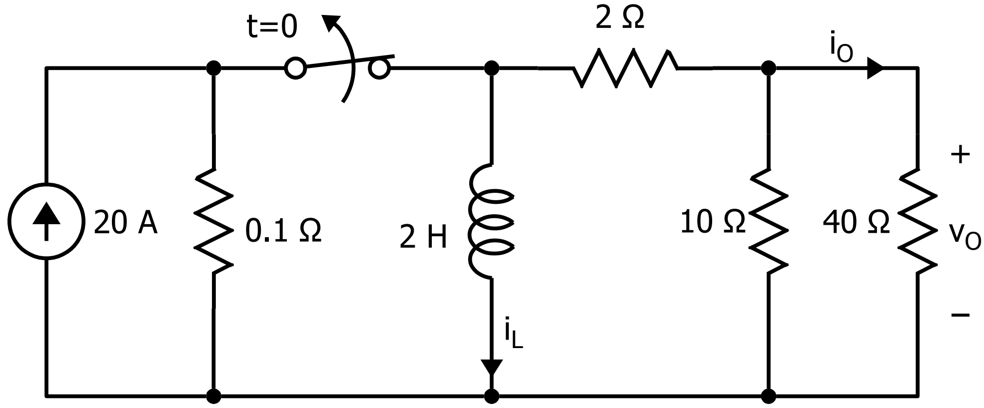
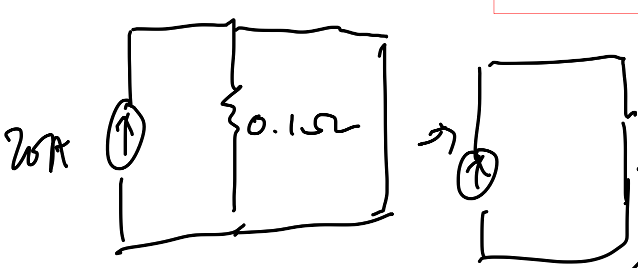
4. The switch has been in the position shown for a long time. Find:
   a. $i_L(0^+)$
   b. $i_O(0^+)$
   c. $v_O(0^+)$
   d. τ for $t=0^+$
   e. $i_L(0^+)$ for all $t>0$
   (HINT: refer to the Lecture 4 video at 22 minutes.)

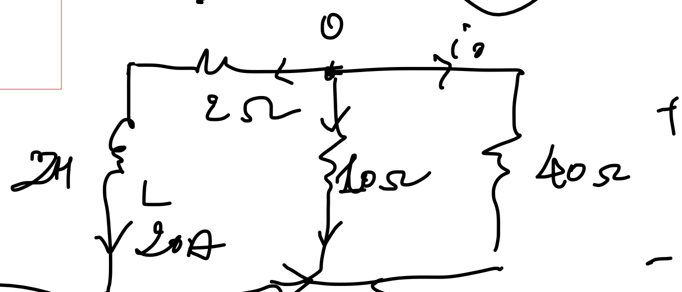


a. $i_L(0^+) = 20\ \text{A}$
b. $i_O(0^+) = -4\ \text{A}$
c. $v_o(0^+) = -160\ \text{V}$
d. $\tau = 0.2\ \text{s}$
e. $i_L(t) = 20e^{-5t}$

$i_L(0^-) = 20A$

$\Rightarrow i_L(0^+) = 20A$





$t=0^+$

$\frac{v-0}{2\Omega}$

$\frac{4v}{4\cdot 10} + \frac{v}{40} + 20 = 0$

$5v = -800 \Rightarrow v = -160(V) \Rightarrow i_o = \frac{-160}{40} = -4(A)$

d)

$R = \frac{10\times 40}{10+40} + 2$

$\Rightarrow \tau = \frac{L}{R} = \frac{2}{10\Omega} = \frac{1}{5} = 0.2(s)$

$i_L = I_0 e^{-t/\tau} = 20e^{-5t}\ (A)$

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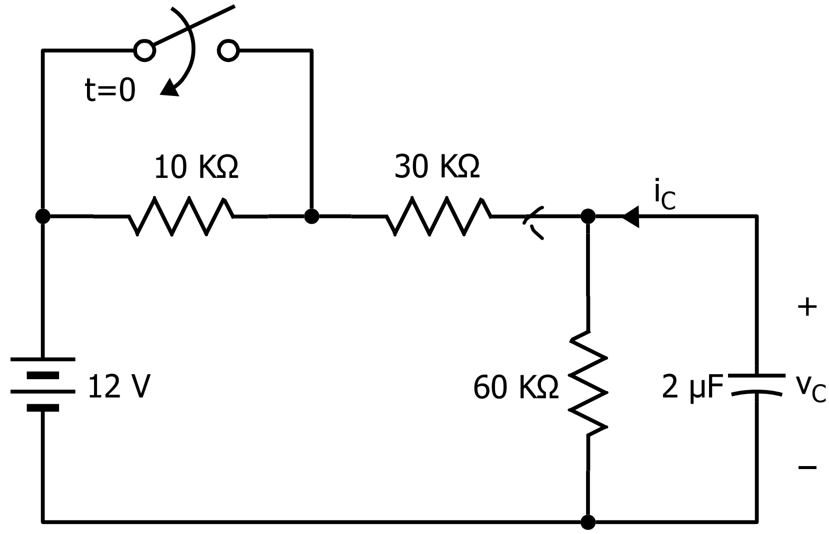
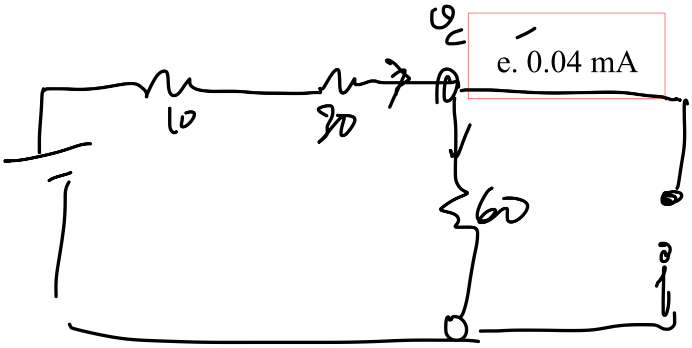
5. The switch has been open for a long time. Find:
   a. $v_C(0^-)$
   b. $v_C(0^+)$ 7.2
   c. $v_C(\infty)$ 8V
   d. $i_C(0^-)$ 0A
   e. $i_C(0^+)$

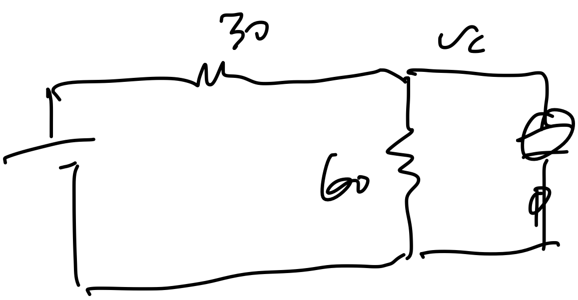




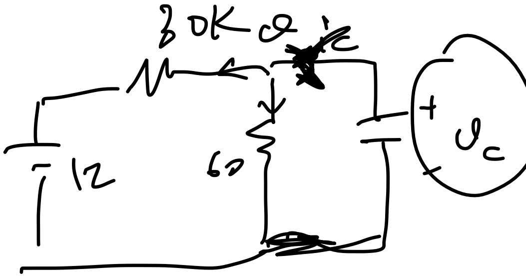
e. 0.04 mA

$V_c = \frac{60}{100} \times 12 = 7.2(V)$

$\to V_c(0^+) = V_c(0^-) = \boxed{7.2V}$



$V_c(\infty) = \frac{60}{90} \times 12 = 8(V)$



$i_c(0^-) = 0$ $\quad t \to 0^+$

$\frac{v-12}{30K} + \frac{v}{60K} + i_c = 0 \quad = i_c$

$\frac{7.2-12}{30K} + \frac{7.2}{60K} = i_c$

$\frac{v}{60} + \frac{2v-24}{2\times30} = i_c$