ECSE-200 Electric Circuits 1 - Quiz #9 (Mar. 22, 2019)

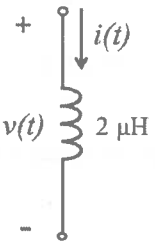
LAST NAME SOLUTIONS **MCGILL ID#** _____

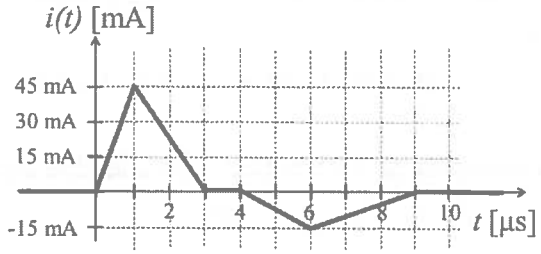
FIRST NAME _____ **SIGNATURE** _____

- ***Only Faculty standard calculator accepted***
- ***No cellphone allowed***
- ***Show all your work***
- ***Clearly indicate your final answer with the SI unit and multiplier***
- ***You have 45 minutes to complete this quiz***

Question 1: Consider the 20 μH inductor (L = 20 μH) shown below along with the diagram illustrating the current *i(t)* flowing through the inductor. Answer the following questions.

$v(t) = L\frac{di(t)}{dt}$





a) What is the voltage *v* at $t = 2$ μs? [1 pt]

b) Plot the voltage *v(t)* versus time *t* indicating the voltage values? [2 pt]

c) What is the instantaneous power at $t = 10$ μs? [1 pt]

d) What is the energy stored as electric potential energy *U(t)* in the inductor at time $t = 4$ μs? [1 pt]

a) $v(2\mu s) = L\left.\frac{di(t)}{dt}\right|_{t=2\mu s} = 2\mu H \cdot \left(\frac{0-45mA}{3-1\mu s}\right) = \frac{-90mA}{2s} = \boxed{-45mV = v(2\mu s)}$

b) $t<0 \rightarrow v = 0V$

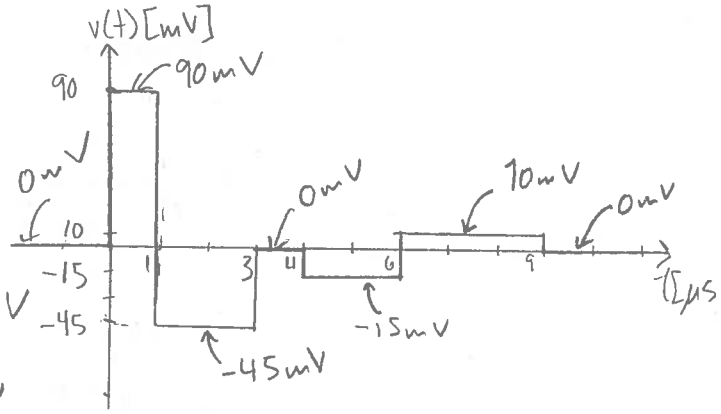
$0<t<1\mu s \quad v = 2\mu H\left(\frac{45mA}{1\mu s}\right) = 90mV$

$0\mu s<t<3\mu s \quad v = -45mV$ (from a))

$3\mu s<t<4\mu s \quad v = 0V$

$4\mu s<t<6\mu s \quad v = 2\mu H\left(\frac{-15mA}{2\mu s}\right) = -15mV$

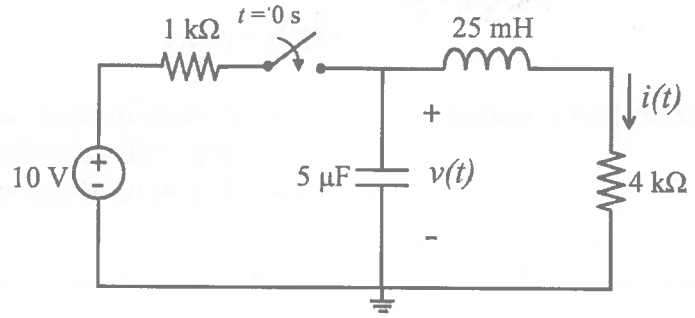
$6\mu s<t<8\mu s \quad v = 2\mu H\left(\frac{15mA}{3\mu s}\right) = 10mV$



c) $p(10\mu s) = i(10\mu s) \cdot v(10\mu) = 0W$ $\boxed{P(10\mu s) = 0W}$

d) $U(t) = \frac{1}{2}Li^2$ $i(4\mu s) = 0A$ $U(t) = 0J$ $\boxed{U(4\mu s) = 0J}$

Question 2: The switch in the switched circuit shown below has been opened for a long time (in other words, the circuit is in steady-state for $t < 0\ s$) before ~~closing~~ the switch at time $t = 0\ s$. Answer the following questions.

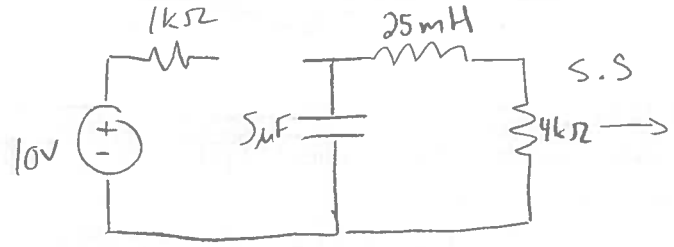


a) Draw the circuit in steady-state for time $t < 0\ s$ and find the values for the voltage $v(t)$ and the current $i(t)$ for $t < 0\ s$. [2 pt]

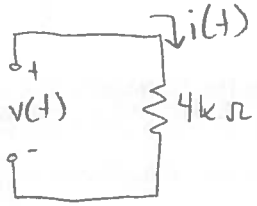
b) Find the values for the voltage $v(t)$ and the current $i(t)$ immediately after the switch closes ($v(0^+)$ and $i(0^+)$)? [2 pt]

c) Draw the circuit in steady-state for time $t \to \infty$ and find the voltage $v(t)$ and the current $i(t)$. [2 pt]

a) $t < 0s$



S.S →



$t < 0s$

$v(t) = 0\ V$

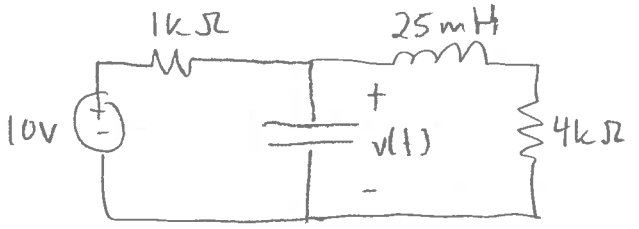
$i(t) = 0\ A$

b) $t = 0^+s$

from continuity of voltage in capacitor $v(0^+) = 0V$

from continuity of current in inductor $i(0^+) = 0A$

c) $t \to \infty$



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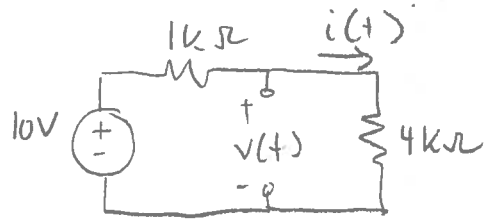

$v(t) = 8V$

$i(t) = 2mA$

$v(t) = 10V \cdot \frac{4k\Omega}{1k\Omega + 4k\Omega} = 8V$

$i(t) = \frac{8V}{4k\Omega} = 2mA$