Due Sunday, Mar. 30, 2025 by 11:59 p.m.

NOTE: This is only the "handwritten" portion of Homework 9. There are also problems you must do online via the Mastering site. For this handwritten portion you must submit a PDF scan of your work at Canvas. Please ensure your work is contained in a single file and is legible.

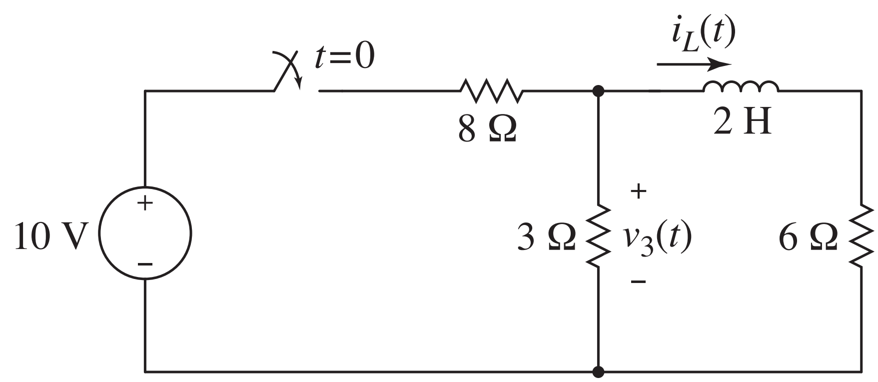
1. At $t = 0$, the switch in the circuit shown below closes, introducing the voltage source to the rest of the circuit. The current flowing through the inductor at $t = 0$ is 0.5 A (thus, the circuit was *not* in steady state just prior to the switch closing).

   (a) What are $v_3(t = 0^-)$ and $v_3(t = 0^+)$?

   (b) What are $i_L(t = \infty)$ and $v_3(t = \infty)$?

   (c) What is the L/R time constant?

   (d) What are the expressions for $i_L(t)$ and $v_3(t)$ for $t > 0$?



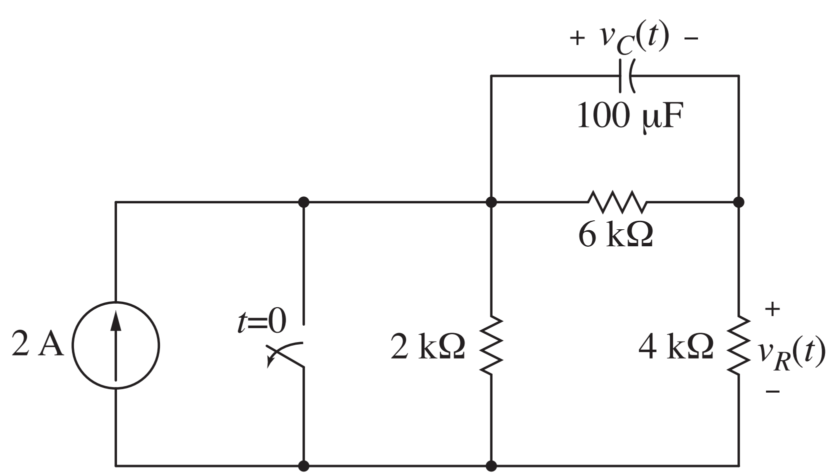
2. At $t = 0$, the switch in the circuit shown below opens, introducing the current source to the rest of circuit. The voltage on the capacitor at $t = 0$ is 10 V (the circuit was *not* in steady state just prior to the switch opening).

   (a) What are $v_R(t = 0^-)$ and $v_R(t = 0^+)$?

   (b) What are $v_C(t = \infty)$ and $v_R(t = \infty)$?

   (c) What is the RC time constant?

   (d) What are the expressions for $v_C(t)$ and $v_R(t)$ for $t > 0$?



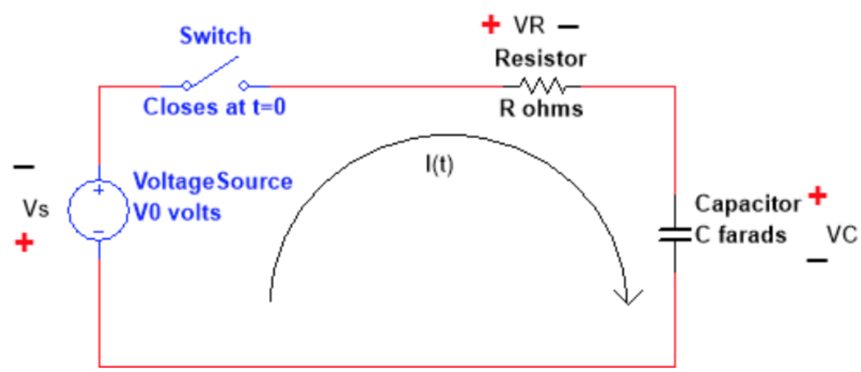
(continued)

3. Do problem 7.84 parts (a) and (b) from Nilson and Riedel.
4. Do problem 7.93 part (a) and (b) from Nilson and Riedel.

The following problem is courtesy of Prof. Brian Faulkner of the Milwaukee School of Engineering.

5. The RC circuit shown below, which serves to charge the capacitor, describes a large number of different machines/devices which will all have some common properties. When charging an initially uncharged capacitor from an ideal voltage source, the voltage and current as a function of time for each component are given by:

$$V_s(t) = -V_0 \tag{1}$$
$$V_{\text{resistor}}(t) = V_0 e^{-t/(RC)} \tag{2}$$
$$V_{\text{capacitor}}(t) = V_0(1 - e^{-t/(RC)}) \tag{3}$$
$$I(t) = \frac{V_0}{R} e^{-t/(RC)} \tag{4}$$



   (a) Derive an expression for the instantaneous power absorbed by the resistor as a function of time.
   (b) Integrate the resistor power as a function of time from $t = 0$ to $t = \infty$, and show the total energy absorbed by the resistor does *not* depend on its resistance. *At all.* This very weird result is the cause of much power loss in memory circuits and much debate on online physics forums.

   Somewhat related to this question, you might enjoy this YouTube video from Up and Atom about "Why pure information gives off heat."
   https://www.youtube.com/watch?v=XY-mbr-aAZE