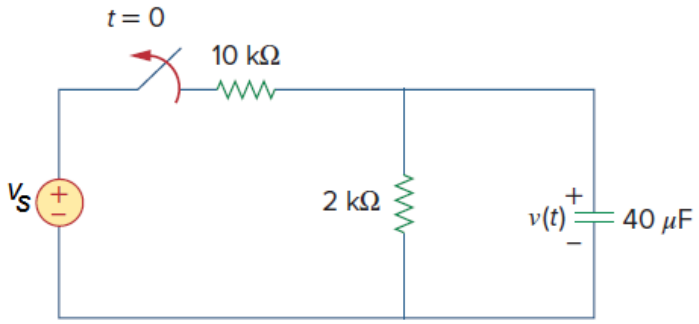
ENGR 065: Circuit Theory

Problem Set #8

Read Chapter 7 and 8 from [1] and then solve the following problems.

Problem 1 [20%]: The switch in the image shown below has been closed for a long time, and it opens at t = 0. Take V_s = 30 V. Find:

a) The initial capacitor voltage (assume DC conditions);
b) The value of $v(t)$ for $t \geq 0$.

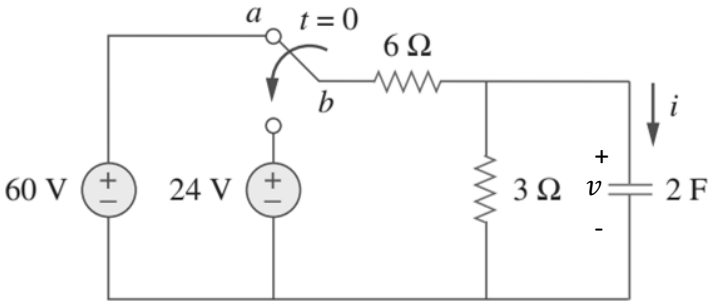


Problem 2 [20%]: The switch in the following circuit has been in position a for a long time. At $t = 0$s it moves to position b. Find:

a) the capacitor voltage $v(t)$ for $t < 0$ assuming DC conditions.

b) the capacitor voltage $v(t)$ for $t > 0$.

c) the capacitor current $i(t)$ for $t > 0$.

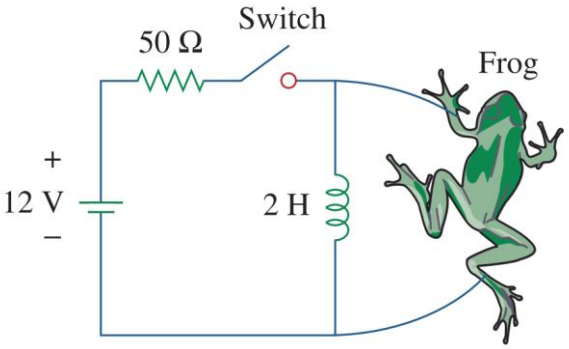


Problem 3 [20%]: The following circuit is used by a biology student to study "frog kick." She noticed that the frog kicked a little when the switch was closed but kicked violently when the switch was opened. Model the frog as a resistor ($R_{frog} = 1000\Omega$). Assume that switch has been closed for a long time

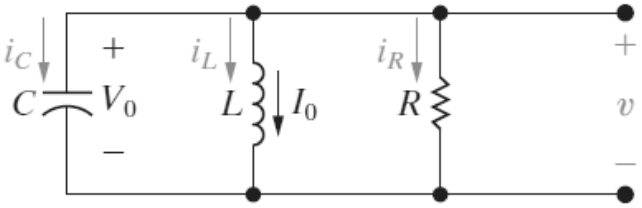
a) Compute the initial inductor current under DC conditions.

b) At $t = 0$s the switches opens. Compute inductor current for $t \geq 0$

c) What is voltage applied to frog for $t \geq 0$? What could a possible reasons for the frog's violent kicks?



Problem 4 [20%]: Consider the following RLC circuit



The inductor has a value $L = 10mH$. The voltage across the capacitor is defined as:

$$v(t) = 40e^{-1000t} - 90e^{-4000t}\ t \geq 0$$

a) Compute the resonant frequency (ω_0) and neper frequency (α) for this circuit.

b) Compute the current $i_C(t)$ assuming $C = 25\mu F$.

Hint: review the example discussed in Lecture 21.

Problem 5 [20%]

a) Use the linearity property to find the Laplace transform of $f(t) = Acos(\beta t)$. *Hint: recall that* $cos(\theta) = \frac{1}{2}(e^{j\theta} + e^{-j\theta})$.

b) Compute the Laplace transform of $v(t)$, when $\frac{dv(t)}{dt} + 6v(t) = 4u(t),\ v(0^-) = -3V.$

c) Find the Laplace transform of the following signal $v(t) = -7u(t)$, where $u(t)$ is a step function

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References

[1] C. Alexander and M. Sadiku “Fundamentals of Electric Circuits”, 7th Edition, 2021, McGraw-Hill