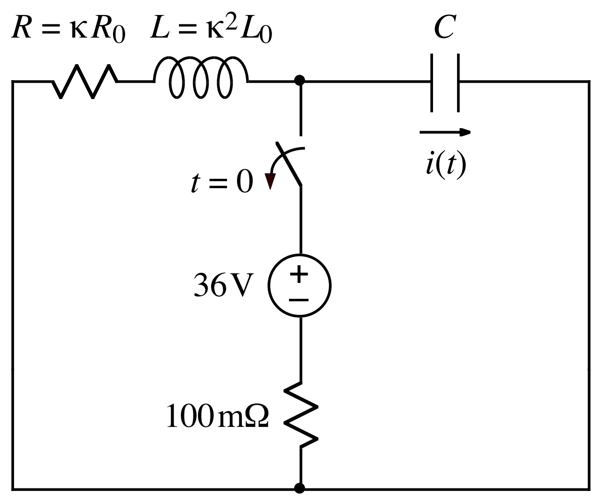
HOMEWORK #9

1.



After being closed for a long time, the switch opens at $t = 0$.

The inductance and resistance in the above circuit form the model of a coil that is made by winding a piece of wire around a plastic rod. The coil has κ turns of wire. One turn of wire would give rise to the following resistance and inductance:

$R_0 = 30\ \text{m}\Omega$ $L_0 = 100\ \text{nH}$

Since resistance is proportional to wire length, the resistance of the coil is proportional to the number of turns:

$R = \kappa R_0.$

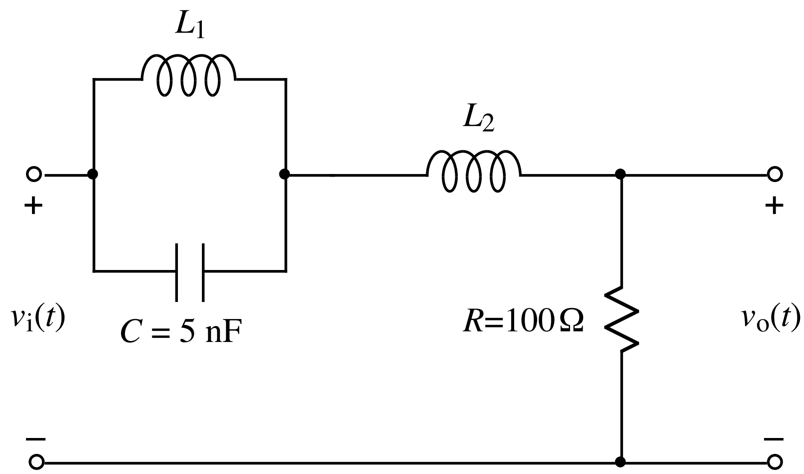
The inductance of the coil, however, is proportional to the number of turns *squared*:

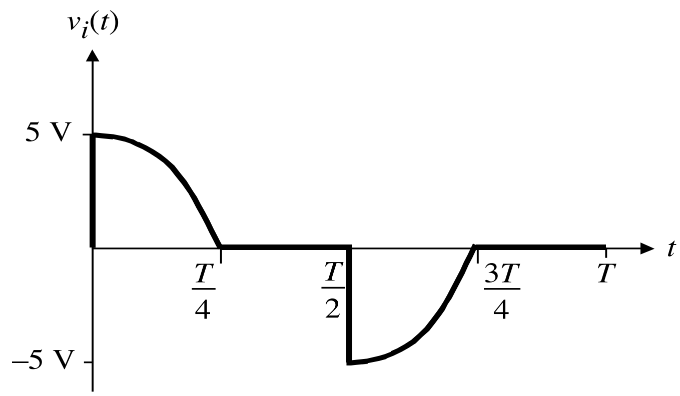
$L = \kappa^2 L_0.$

Find the number of turns, κ, and the value of C that make the circuit critically damped with a characteristic root $s = -5\text{k}$ rad/s.

2. Using the component values from problem 1, find a numerical expression for $i(t)$ for $t > 0$.

3.





T = one period of $v_i(t) = 0.8 \cdot \pi$ μs

$$v_i(t) = \begin{cases} 5\cos(\omega_0 t) \text{ V} & 0 < t \le T/4 \\ 0 \text{ V} & T/4 < t \le T/2 \\ 5\cos(\omega_0 t) \text{ V} & T/2 < t \le 3T/4 \\ 0 \text{ V} & 3T/4 < t \le T \end{cases}$$

Find values of $L_1 \neq 0$ and $L_2 \neq 0$ for the above filter circuit such that the transfer function equals zero for the fourth harmonic and one for the eighth harmonic of $v_i(t)$, also shown above.

4. Find numerical values of coefficients a_v, a_1, a_2, b_1, and b_2 for the Fourier series for $v_i(t)$ from problem 3:

$$v_i(t) = a_v + \sum_{k=1}^{\infty} a_k \cos(k\omega_0 t) + b_k \sin(k\omega_0 t)$$