ECE 2260 hw04

1. Natural Response of a Parallel RLC Circuit

The circuit elements in the circuit in Fig. 1 are $R = 125\ \Omega$, $L = 200$ mH, and $C = 5$ µF. The initial inductor current is -300 mA and the initial capacitor voltage is 25 V.

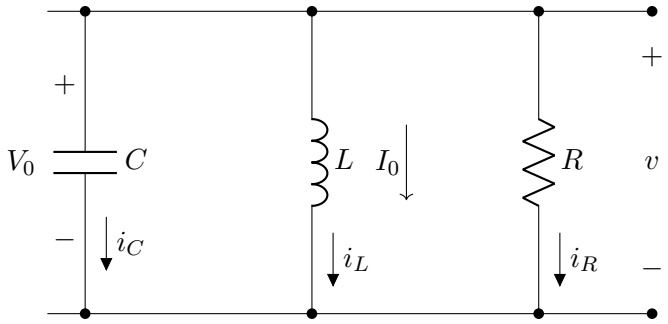

Figure 1: A circuit used to illustrate the natural response of a parallel RLC circuit.

a) Calculate the initial current in each branch of the circuit.

b) Find $v(t)$ for $t \geq 0$.

c) Find $i_L(t)$ for $t \geq 0$.

2. Parallel RLC Circuit Response

The resistance, inductance, and capacitance in a parallel *RLC* circuit are 2000 Ω, 250 mH, and 10 nF, respectively.

a) Calculate the roots of the characteristic equation that describe the voltage response of the circuit.

b) Will the response be over-, under-, or critically damped?

c) What value of R will yield a damped frequency of 12 krad s^{-1}?

d) What are the roots of the characteristic equation for the value of R found in (c)?

e) What value of R will result in a critically damped response?

3. Damping in Parallel RLC Circuits

A parallel, natural response RLC circuit is in its simplest form (a resistor R, an inductor L, and capacitor C all in parallel). Given the following component values, determine if the response is over-damped, under-damped, or critically damped.

(i) $R = 400\ \Omega$, $L = 25$ mH, and $C = 25$ nF

(ii) $R = 625\ \Omega$, $L = 25$ mH, and $C = 25$ nF

4. Circuit with Synchronous Switches

The two switches in the circuit seen in Fig. 2 operate synchronously. When switch 1 is in position a, switch 2 is in position d. When switch 1 moves to position b, switch 2 moves to position c. Switch 1 has been in position a for a long time. At $t = 0$, the switches move to their alternate positions. Find $v_o(t)$ for $t \geq 0$.

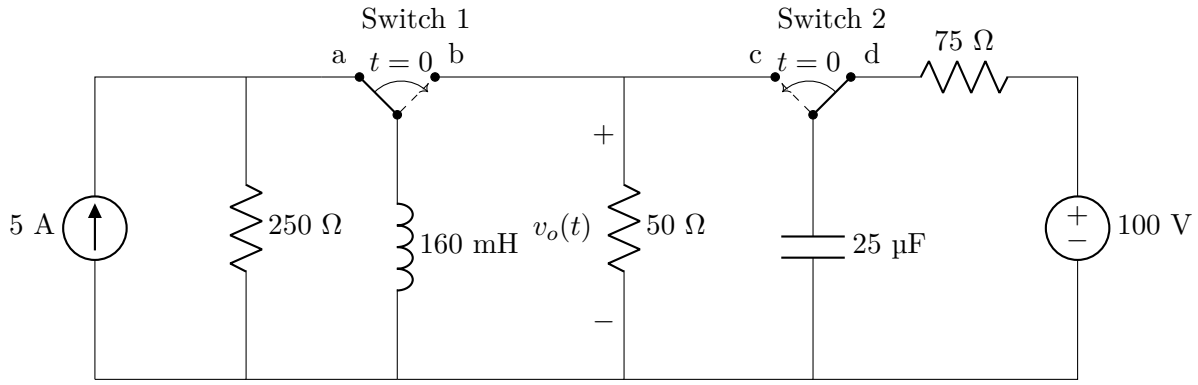

Figure 2: Circuit for problem.

5. Circuit with Dependent Source

The switch in the circuit of Fig. 3 has been in position a for a long time. At $t = 0$ the switch moves instantaneously to position b. Find $v_o(t)$ for $t \geq 0$.

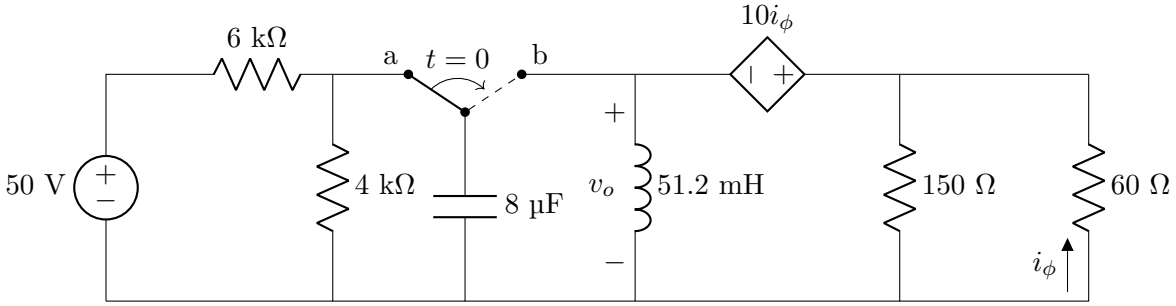

Figure 3: Circuit for problem.

6. RLC Step Response

The left switch in the circuit in Fig. 4 has been closed for a long time. The right switch has been open for a long time. At time $t = 0$, the left switch opens, and the right switch closes simultaneously.

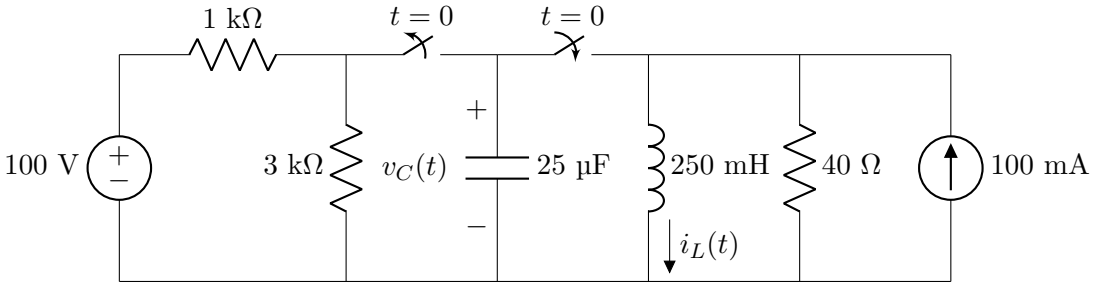

Figure 4: Circuit for problem.

a) $i_L(t)$ for $t \geq 0$,

b) Find $v_C(t)$.