

# ECE 2260 hw02

## 1. Op-amp circuit analysis

The op amp in the circuit of Fig. 1 is ideal.

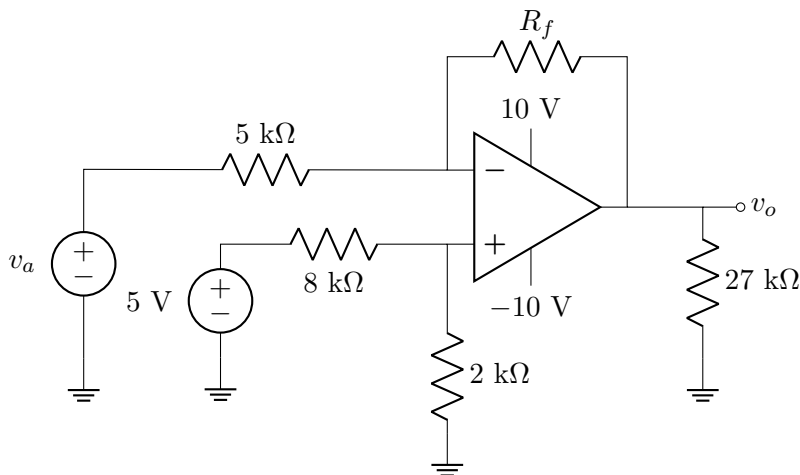


Figure 1: Op amp circuit

- What op amp circuit configuration is this?
- Find an expression for the output voltage  $v_o$  in terms of the input voltage  $v_a$  (assume that  $R_f = 20 \text{ k}\Omega$ ).
- Suppose  $v_a = 2 \text{ V}$ . What value of  $R_f$  will cause the op amp to saturate?

## 2. Inductor current and voltage analysis

The current in a 150  $\mu\text{H}$  inductor is known to be

$$i_L = 25te^{-500t} \text{ A} \quad \text{for } t \geq 0.$$

- a) Find the voltage across the inductor for  $t > 0$ . (Assume the passive sign convention.)
- b) Find the power (in  $\mu\text{W}$ ) at the terminals of the inductor when  $t = 5 \text{ ms}$ .
- c) Is the inductor absorbing or delivering power at 5 ms?
- d) Find the energy (in  $\mu\text{J}$ ) stored in the inductor at 5 ms.
- e) Find the maximum energy (in  $\mu\text{J}$ ) stored in the inductor and the time (in ms) when it occurs.

### 3. Capacitor voltage and current analysis

The voltage at the terminals of the capacitor in Fig. 2 is known to be

$$v = \begin{cases} 60 \text{ V}, & t \leq 0; \\ 30 + 5e^{-500t}(6 \cos 2000t + \sin 2000t) \text{ V}, & t \geq 0. \end{cases}$$

Assume  $C = 120 \text{ }\mu\text{F}$ .

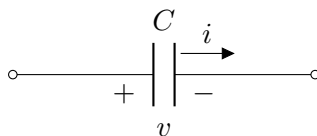


Figure 2: Capacitor circuit for problem.

- a) Find the current in the capacitor for  $t < 0$ .
- b) Find the current in the capacitor for  $t > 0$ .
- c) Is there an instantaneous change in the voltage across the capacitor at  $t = 0$ ?
- d) Is there an instantaneous change in the current in the capacitor at  $t = 0$ ?
- e) How much energy (in mJ) is stored in the capacitor at  $t = \infty$ ?

#### 4. RL circuit with switch

The switch in the circuit in Fig. 3 has been open for a long time. At  $t = 0$  the switch is closed.

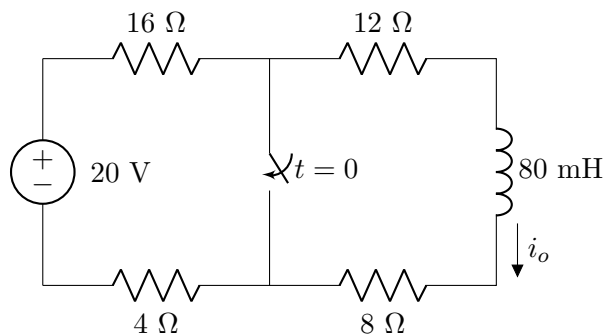


Figure 3: Circuit for Problem 7.1

- Determine  $i_o(0)$  and  $i_o(\infty)$ .
- Determine  $i_o(t)$  for  $t \geq 0$ .
- How many milliseconds after the switch has been closed will  $i_o$  equal 100 mA?

## 5. RL circuit with opening switch

The switch in the circuit in Fig. 4 has been closed for a long time. At  $t = 0$  it is opened.

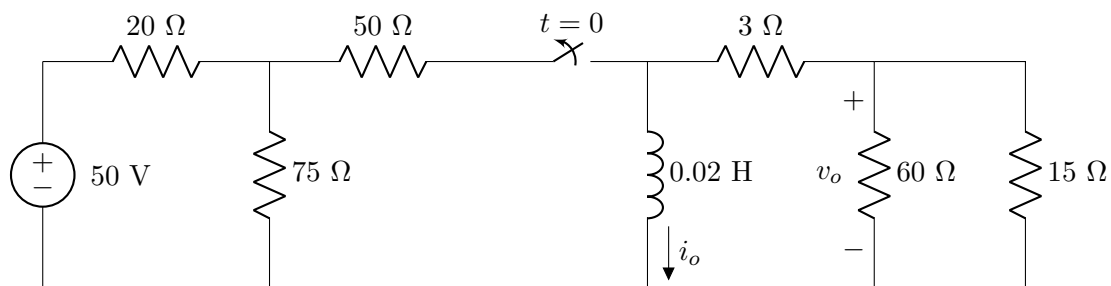


Figure 4: Circuit for Problem 7.2

- Write the expression for  $i_o(t)$  for  $t \geq 0$ .
- Write the expression for  $v_o(t)$  for  $t \geq 0^+$ .

## 6. Make-before-break switch

In the circuit shown in Fig. 5, the switch makes contact with position b just before breaking contact with position a. As already mentioned, this is known as a make-before-break switch and is designed so that the switch does not interrupt the current in an inductive circuit. The interval of time between “making” and “breaking” is assumed to be negligible. The switch has been in the a position for a long time. At  $t = 0$  the switch is thrown from position a to position b.

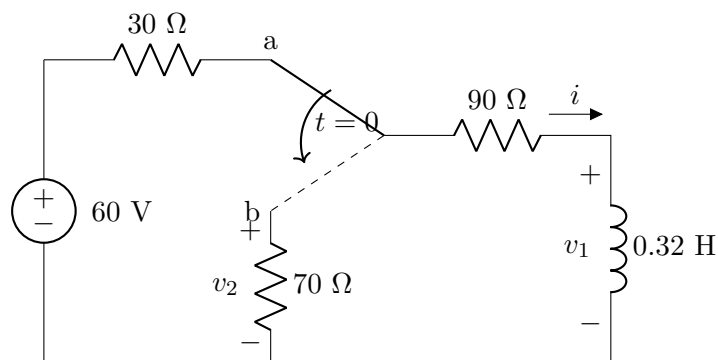


Figure 5: Circuit for Problem 7.3

- Determine the initial current in the inductor.
- Determine the time constant of the circuit for  $t > 0$ .
- Find  $i$ ,  $v_1$ , and  $v_2$  for  $t \geq 0$ .

## 7. Switching circuit with inductor

The switch in the circuit in Fig. 6 has been in position 1 for a long time. At  $t = 0$ , the switch moves instantaneously to position 2. Find  $v_o(t)$  for  $t \geq 0^+$ .

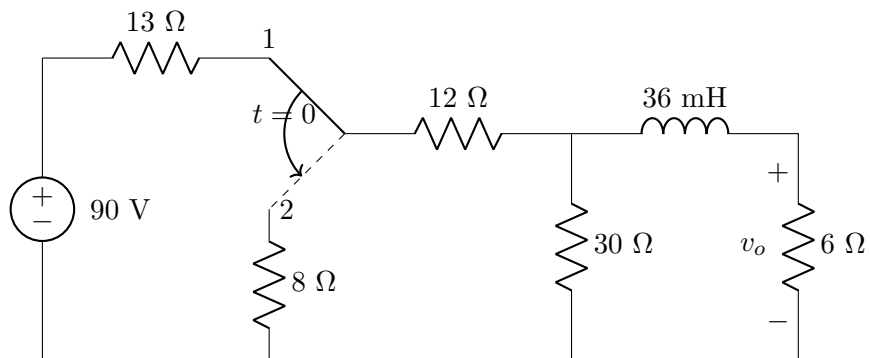


Figure 6: Switching circuit

## 8. Switched RC Circuit Analysis

The switch in the circuit in Fig. 7 has been in position a for a long time and  $v_2 = 0$  V. At  $t = 0$ , the switch is thrown to position b.

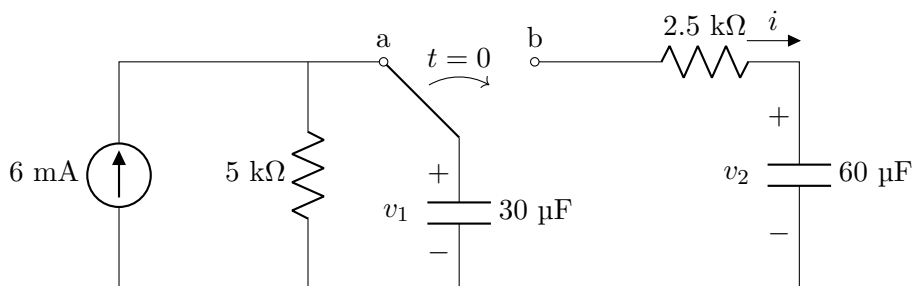


Figure 7: Circuit with multiple capacitors

Calculate  $i(t)$ ,  $v_1(t)$ , and  $v_2(t)$  for  $t \geq 0^+$ .