Homework 4

Due date:
Apr. 14th, 2021
Turn in your homework in class

Rules:

- Please work on your own. Discussion is permissible, but extremely similar submissions will be judged as plagiarism!
- Please show all intermediate steps: a correct solution without an explanation will get zero credit.
- Please submit on time. No late submission will be accepted.
- Please prepare your submission in English only. No Chinese submission will be accepted.

1. [8%] Equivalent capacitance and inductance
   a) Obtain the equivalent capacitance of the circuit at terminals a and b in **Fig. 1(a).**
   b) Obtain the equivalent inductance of the circuit at terminals a and b in **Fig. 1(b).**

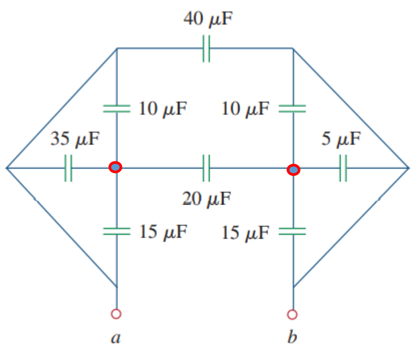

Fig. 1(a).

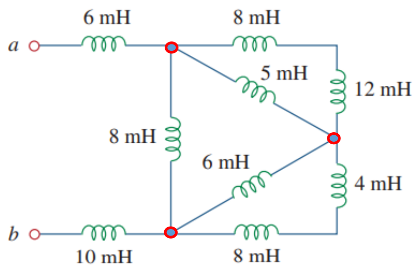

Fig. 1(b).

2. [10%] Assume the switch is open for a long time and the system is stable when $t < 0$. Then the switch is closed at time $t = 0$. Use the circuit as shown in **Fig 2**:
   a) Find the total energy delivered to the inductor in the time period [0, ∞].
   b) Find the total energy delivered to the capacitor in the time period [0, ∞].

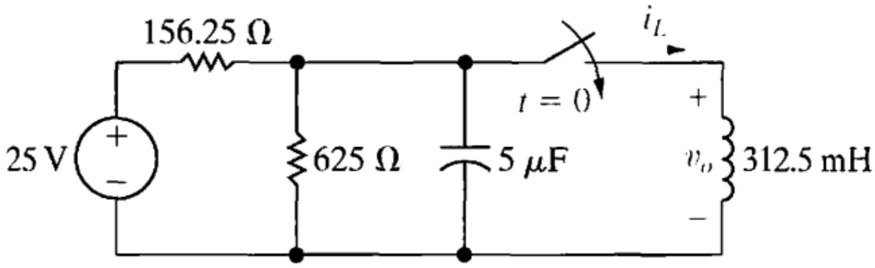

Fig. 2.

3. [13%] At $t = 0$, the voltage signal of **Fig. 3(b)** is applied to the cascaded integrating amplifiers shown in **Fig.3 (a)**. There is no energy stored in the capacitors when $t = 0^{-}$. Find $v_{01}(t)$ and $v_0(t)$ for $t > 0$.

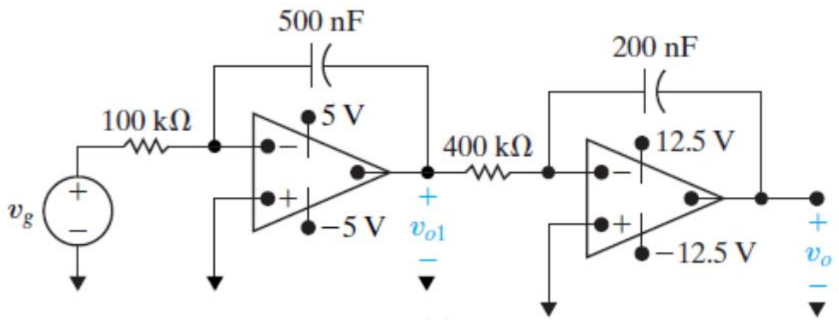

Fig. 3(a).

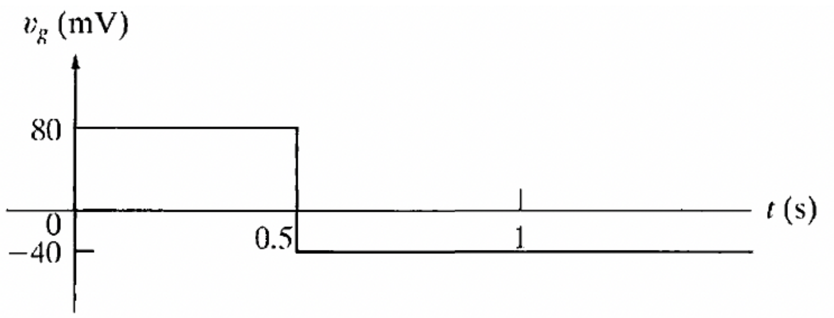

Fig. 3(b).

4. [15%] In the circuit shown in **Fig. 4**, the switch is closed at $t = 0s$ and re-opened at $t = 0.5s$. Given $V_S = 18\text{V}$, $R_S = 1\Omega$, $R_1 = 5\Omega$, $\text{R}_2 = 2\Omega$, $L = 2\text{H}$ and $C = \frac{1}{17}\text{F}$. Determine the response for $i_L(t)$ of $t \geq 0$. There is no energy stored in the inductor and capacitor when $t < 0$.

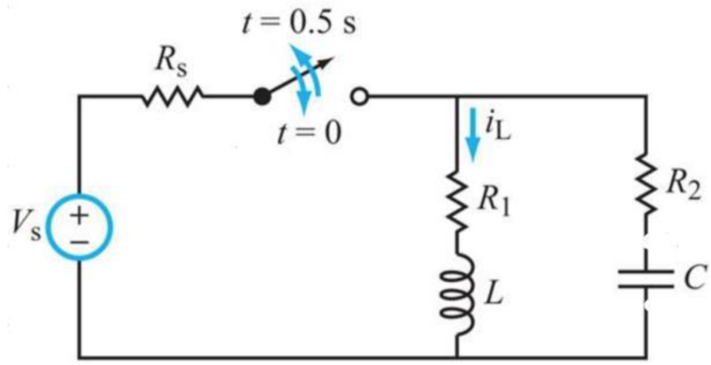

Fig. 4.

5. [10%] In the circuit below, $R_1 = 10\Omega$, $R_2 = 5\Omega$, $L = 4\text{mH}$, $C = 10\text{mF}$. When $t < 0$, the input voltage (U) is 5V. When $t = 0$, the input voltage charges to U =12V. Assume that the circuit reaches steady state before $t = 0$. Determine the expression for $\mathrm{V_C}(t)$ when $t \geq 0$.

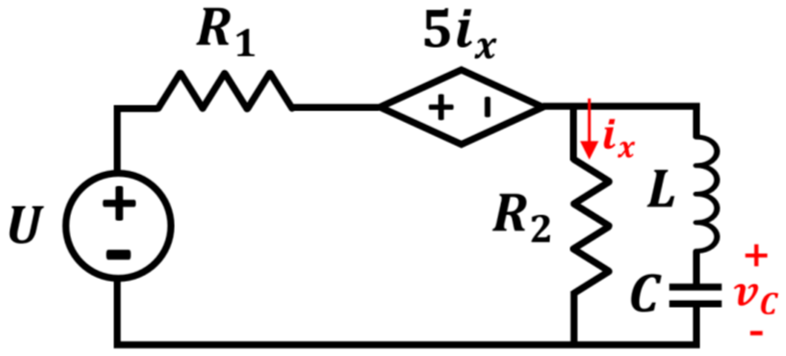

Fig. 5.

6. [12%] The circuit is shown in **Fig.6.** the gap in the circuit seen in figure will be shorted whenever the voltage across the gap reaches $30\ kV$. The initial current in the inductor is zero. The value of β is adjusted so the Thevenin resistance with respect to the terminals of the inductor when the switch is closed is $-4\ k\Omega$(Thevenin equivalent to the rest of the circuit excluding the inductor; assuming the gap remains open circuit during the Thevenin equivalencing).
   (1) What is the value of β?
   (2) How many microseconds after the switch is closed will the gap be shorted?

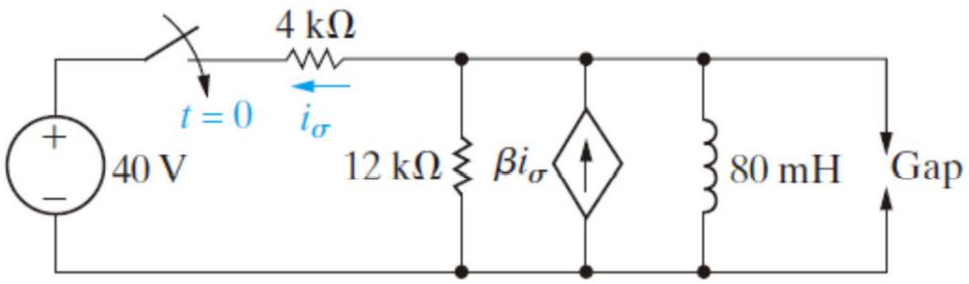

Fig.6.

7. [20%] The initial value of the voltage $v(0^+)$ in the circuit shown in **Fig. 7** is zero, and the initial value of the capacitor current, $i_c(0^+)$, is 45mA. The expression for the capacitor current is known to be $i_c(t) = A_1e^{-200t} + A_2e^{-800t}, t > 0.$ $R = 250\Omega$ Find

   a) The values of L, C, A_1 and A_2.

   b) The express for $v(t)$, $t \geq 0$.

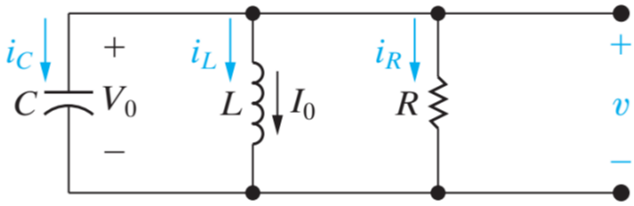

Fig. 7.

8. [12%] Consider a simple series RLC circuit. Before t=0 there is no energy stored in the capacitor and inductor. The switch is closed at $t = 0$. The voltage source is:

$$V(t) = 32e^{-40t}V, t > 0$$

Express i_L, knowing that $R = 75\Omega$, $C = 0.125F$ and $L = 4H$.

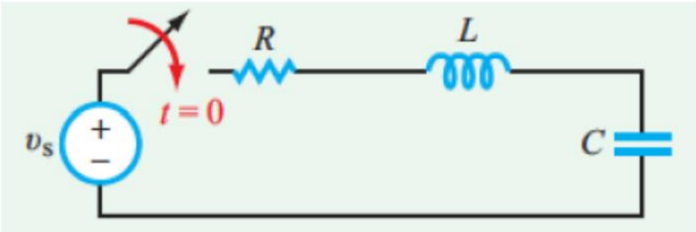

Fig. 8.