BIRZEIT UNIVERSITY

FACULTY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF COMPUTER ENGINEERING

Circuit Analysis
ENEE 2304

Project

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1. Introduction

This is the report for the final project in Circuit course, in this project we will use pspice program 9.1 version. We will include circuit analysis and how to deal with it and build it on the program in addition to screenshots of the circuits that done in the program and screenshots for simulations.

2. Theory

2.1. RL circuit

An electric circuit comprising of resistors and inductors operated by a voltage or current source is known as a resistor–inductor circuit (RL circuit), RL filter, or RL network. The simplest sort of RL circuit is a first-order RL circuit, which consists of one resistor and one inductor.

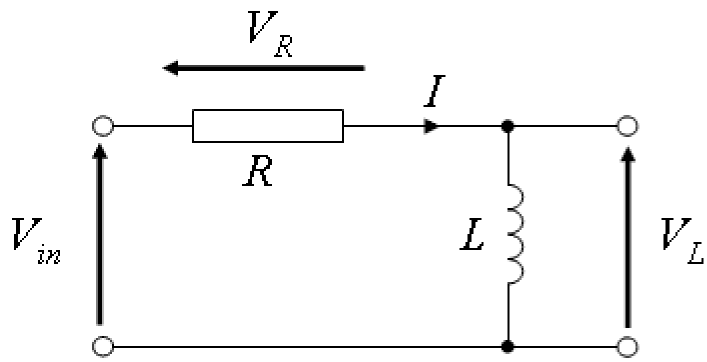


Figure 1: RL circuit

2.2. Step response

The step response of a circuit is its behavior when the excitation is the step function, which may be a voltage or a current source.

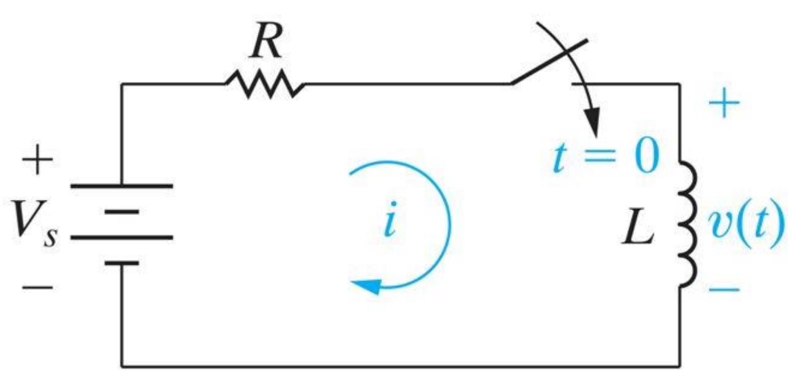


Figure 2: step response RL circuit

3. Procedure

3.1. Circuit analysis

We notice from the circuit below that it is step response First Order RL circuit because at time 0 when the key changes, it remains their voltage source with the indicator and since there is only an inductor and no capacitor, it is first order. We want to find $V_0(t)$ for $t > 0$.

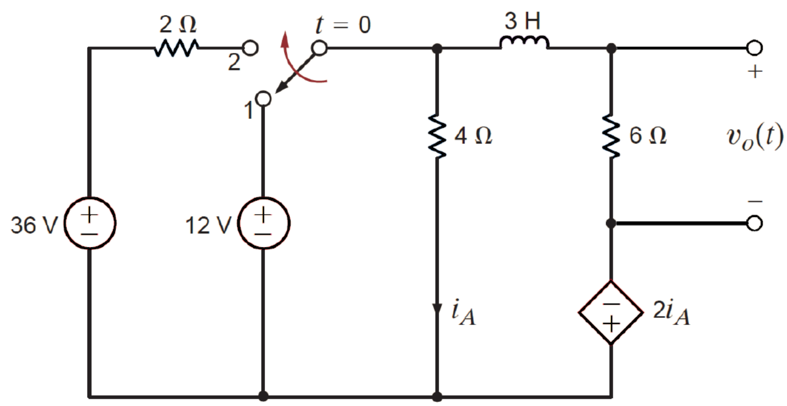


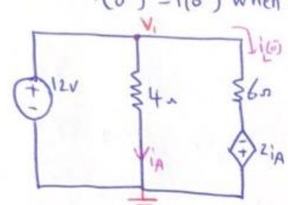
Figure 3: step response First Order RL circuit

3.2. Theoretical solution

$\Rightarrow i_L(t) = i_f + [i_i - i_f]e^{-t/\tau}$

[Tarik odeh 1190699]

⊛ To find $i(0^+) = i(0^-)$ when $t < 0 \rightarrow t = 0^-$



Node (V_1)

$V_1 = 12$ Volt

(KVL)

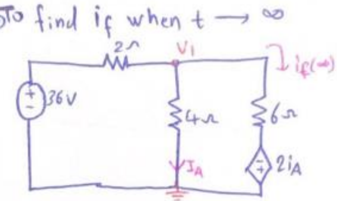
$V_1 = 6i(0^-) - 2i_A$

But $I_A = \frac{V_1}{R} = \frac{12}{4} = 3A$

$12 = 6I(0^-) - 6$

$\boxed{I(0^-) = \frac{18}{6} = 3A}$

⊛ To find i_f when $t \rightarrow \infty$



$\frac{V_1 - 36}{2} + \frac{V_1}{4} + \frac{V_1 + 2i_A}{6} = 0$

$\left(\frac{1}{2} + \frac{1}{4} + \frac{1}{6}\right)V_1 - \frac{36}{2} + \frac{i_A}{3} = 0$

But $I_A = \frac{V_1}{4}$.

$\left(\frac{1}{2} + \frac{1}{4} + \frac{1}{6} + \frac{1}{12}\right)V_1 = \frac{36}{2}$

$V_1 = 18$ Volt

(KVL)

$V_1 = 6I(\infty) - 6$

$18 = 6I(\infty) - 6$

$\boxed{I(\infty) = 4.5A}$

Figure 4: theoretical results-1

⊛ To find $\tau = \frac{L}{R_{eq}}$ → $L = 3H$

→ R_{eq} by thevenin therom $R_{Th} = \frac{V_{Th}}{I_{s.c}}$

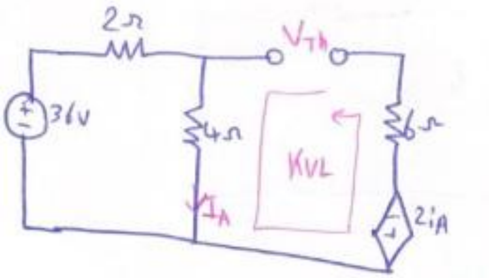
⇒ To find V_{Th}

(KVL)

$4I_A + 2I_A = V_{Th}$

But $I_A = \frac{36}{6} = 6A$

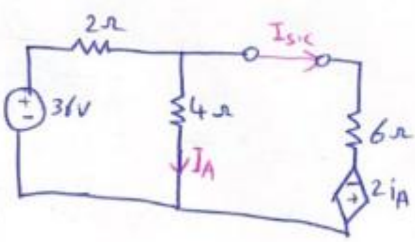
$\boxed{V_{Th} = 36 \text{ Volt}}$



⇒ To find $I_{s.c}$

$\boxed{I_{s.c} = 4.5 A}$

(same way as before in i_f)



∴ $R_{Th} = \frac{36}{4.5} = 8\Omega$

$\tau = \frac{3}{8} = 0.375$

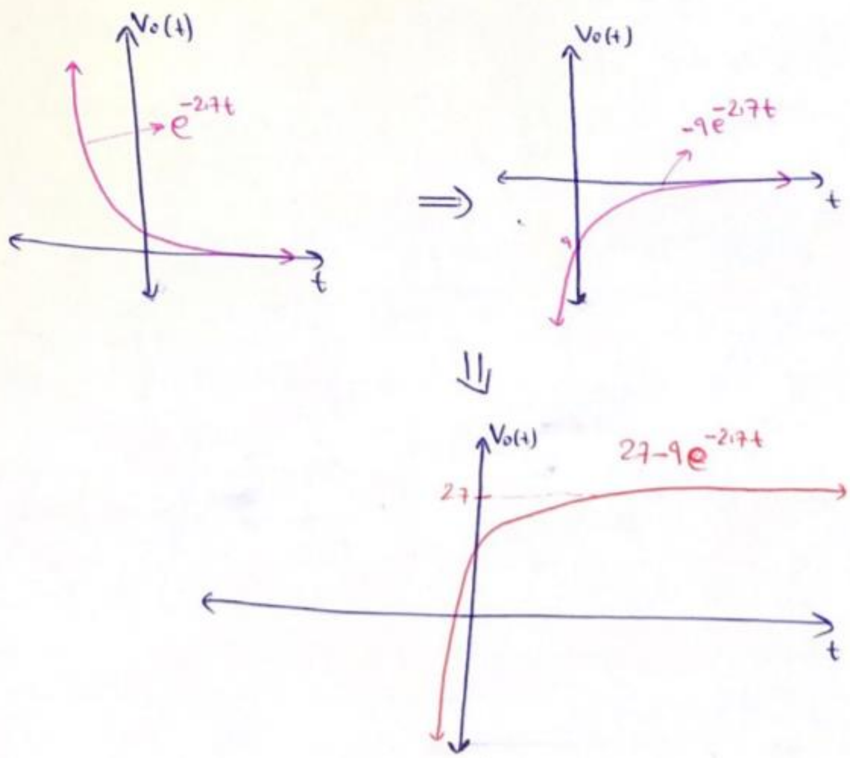
$i_L(t) = I_f + [I_{Li} - I_{Lf}] e^{\frac{-t}{\tau}}$

$= 4.5 + [3 - 4.5] e^{-2.7t}$, $t > 0$

$V_o(t) = I_L(t) * 6$

$\boxed{V_o(t) = 27 - 9e^{-2.7t} \quad , \text{for } t > 0}$

Figure 5: theoretical results-2



⇒ So beard on the theoretical result $V_o(t)$ is expnential function.

⇒ when $t \to \infty$

$$V_o(t) = 27 - 9e^{-2.7\infty}$$
$$= 27 - 0$$
$$= 27 \text{ Volt.}$$

Figure 6: theoretical results-3

3.3. Practical solution

Initially we designed the full circuit with the value of each element as shown in figure 6.

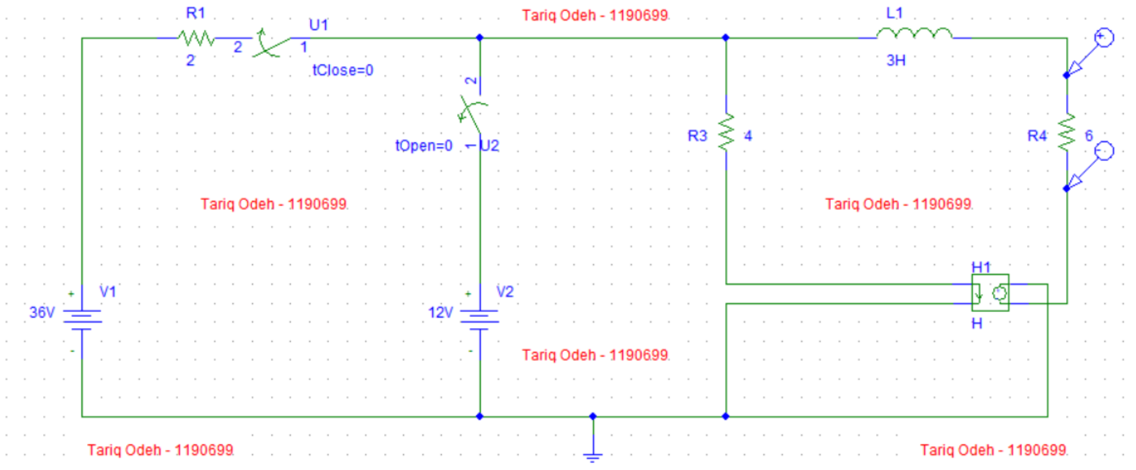


Figure 7: Circuit schematic

After that, we shown the voltages and current in each element as shown in figure 7, and finally, I made the final simulation for the circuit.

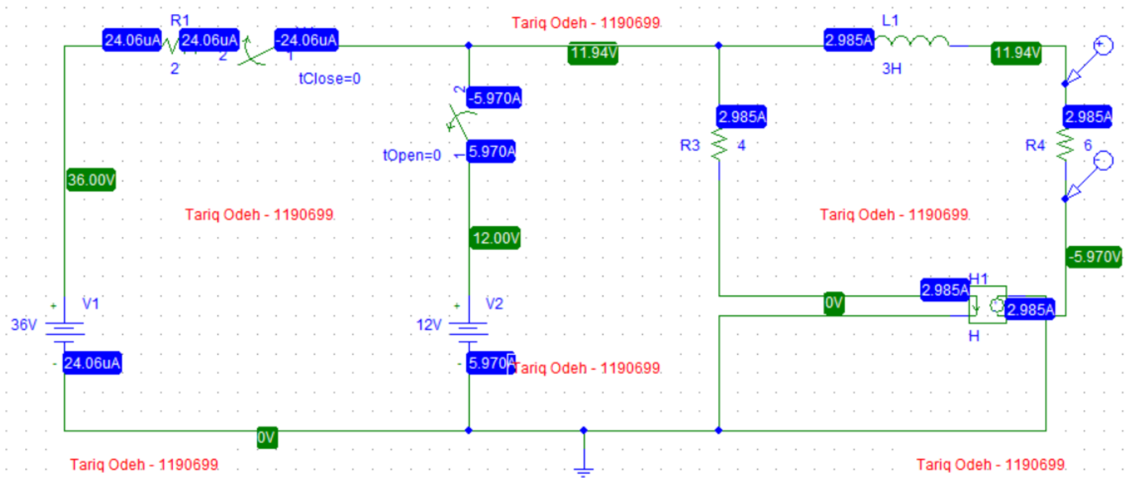


Figure 8: Circuit simulation

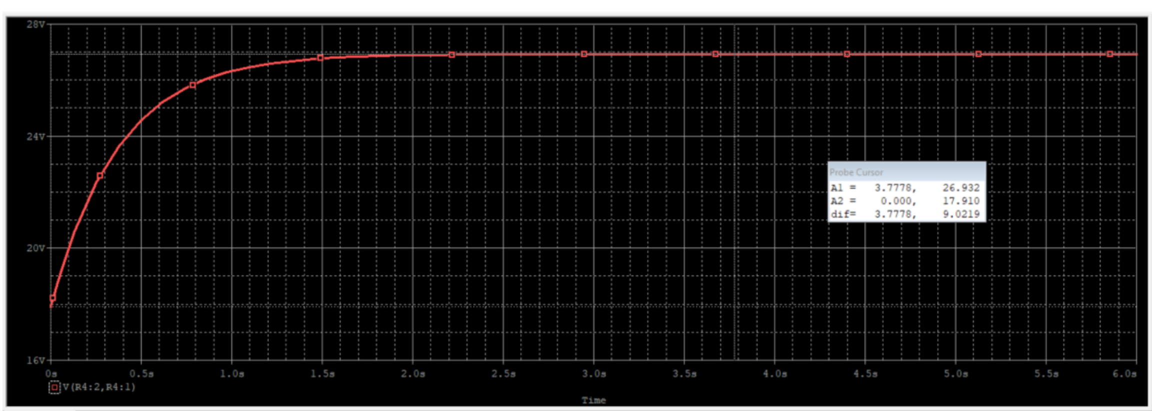


Figure 9: Graph for V0(t)

4. Conclusion

In this experiment, we obtained theoretical and practical results for the circuit, and we noticed that the practical results were the same as the theoretical results, as it was the theoretical result $V_0(t) = 27 - 9e^{-2.7t}$ and we note in the practical result that produced a drawing exponential function $V_0(t) = 27 - 9e^{-2.7t}$ similar to the theoretical result.

In the theoretical at infinite time, the value of $V_0(t)$ is equal to 27- 0 = 27, and we note from the figure below that at infinite time, the value of $V_0(t)$ is 27 volts.

And from the figure below if we take any time, for example t = 2.7009 s, and substitute it in the theoretical value $V_0(t) = 27 - 9e^{-(2.7)(2.7009)} = 26.926$ volt, we note that the result is the same, and this indicates that the circuit is working correctly.

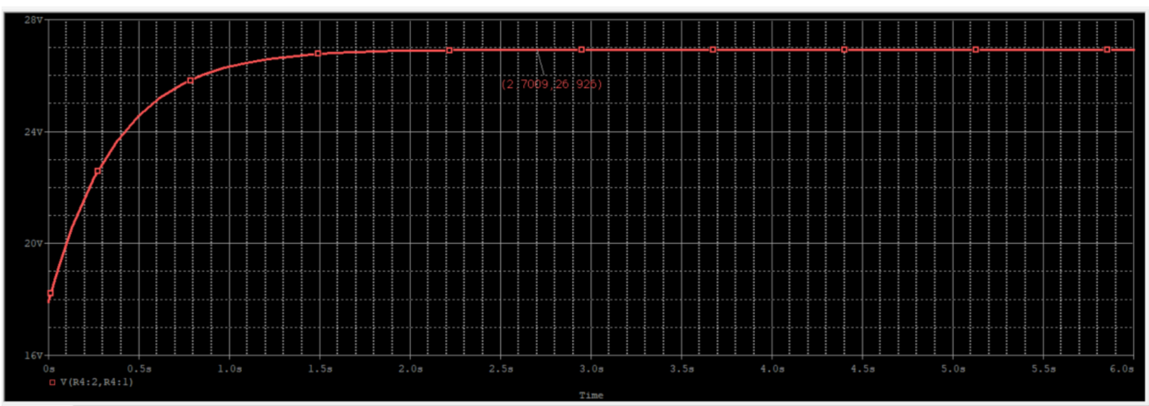


Figure 10: Graph for V0(t) & point

5. References

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