Laboratory 8: Transient Responses of First Order RL and RC Circuits

Adrian Darian

12/2/2020

Objectives

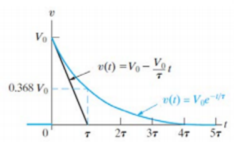
- Observe the transient responses of RL and RC circuits.
- Learn to how to measure time constant of first order circuits.

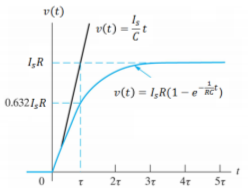
Equipment and components

- A computer
- PSPICE software

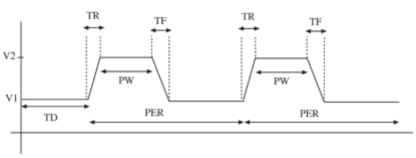
Preliminary

- Read the lecture slides of "Inverse Laplace Transform and RC, RL, and RLC Circuits".
- Calculate the time constant when $R = 1\text{k}\Omega, C = 0.5\mu F, C = 1\mu F, andC = 2\mu F$, respectively. Fill in Table 1. Refer to the natural and step responses of RC circuits shown below for finding the time constant.





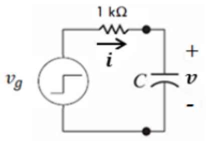
- Calculate the time constant when $R = 10\Omega, L = 10mH, L = 20mH, andL = 40mH$, respectively. Fill in Table 2. Refer to the above two graphs to find the time constant for RL circuits.
- Pulse waveform: A voltage pulse source can be applied using VPULSE element in PSpice. VPULSE has 7 parameters that are described and shown below.



As an example, a square waveform can be created by setting $TR = TF = 0$ and $PER = 2PW$. TD is the delay time

Procedure

1. Open PSpice and construct a circuit shown below with a resistor of 1kΩ and a capacitor of $1\mu F$. V_g is an independent voltage source generating square waveforms. Set $TR = TF = TD = 0, V_1 = 0, and V_2 = 10V$ Wisely set the period of the waveform so that you can clearly observe the natural and step responses $v(t)$ of the RC Circuit.



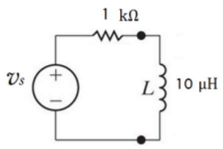
2. Measure $i(t)$ and $v(t)$. Plot them. What did you find? Why?

3. Fill the simulation results in Table 1

Resistance (kΩ)	Capacitance (μF)	Calculated Time Constant (ms)	Measured Time Constant (ms)
1	0.5	0.5	1
1	1	1	0.5
1	2	2	2

4. let $R = 1\text{k}\Omega and TR = TF = TD = 0, V_1 = 0, V_2 = 10V, and PER = 2ms$, select the capacitance of the capacitor so that the response $v(t)$ of the circuit is a triangle waveform, as shown below.

5. Construct a circuit shown below with a resistor of 10kΩ and an inductor of $10mH$. Set $TR = TF = TD = 0, V_1 = 0, V_2 = 10V$ for the pulse voltage source. Wisely select it pulse width so that you can clearly observed the responses of the RL circuit.



6. Measure the current $i(t)$ in the circuit and voltage $v(t)$ across the inductor. Then plot them. What did you find? Why?

7. Fill the simulation results in Table 2

Resistance (Ω)	Capacitance (mH)	Calculated Time Constant (ms)	Measured Time Constant (ms)
10	10	100	200
10	20	200	100
10	30	300	300

Questions and Conclusions

• Summarize your findings and explanations in response to the questions posed in this lab.
In this lab I learned more about how a capacitor works in a practical stand point. I really found out that capacitors work different from one another and the data fluxtuates frequently. This is primarily due to the sinusoidal power source. Whenever I flipped the switch back and forth the readings would scatter and then slowly realign. In the end the larger the capcitor the longer a light can be charged.