ENGR 065 Circuit Theory

Laboratory 8

Transient Responses of First Order RL and RC Circuits

Objectives

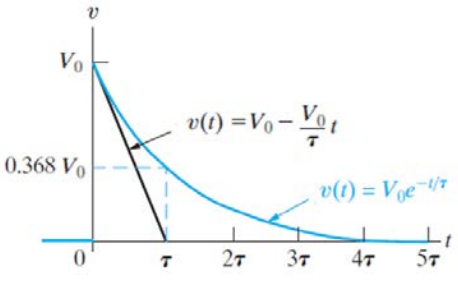
- Observe the transient responses of RL and RC circuits.
- Learn to how to measure time constant of first order circuits.

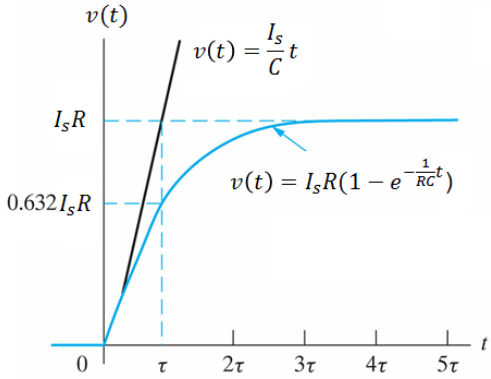
Equipment and components

- A computer
- PSPICE software

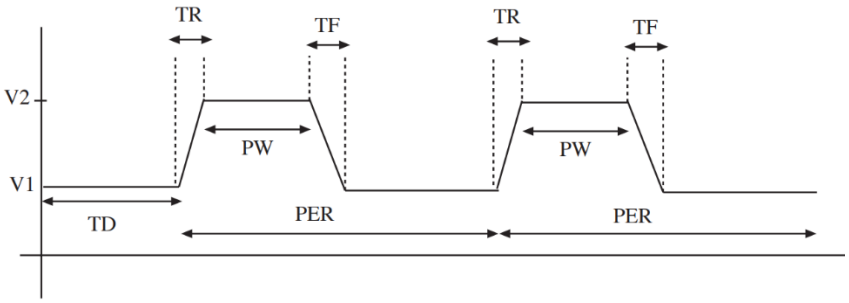
Preliminary

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





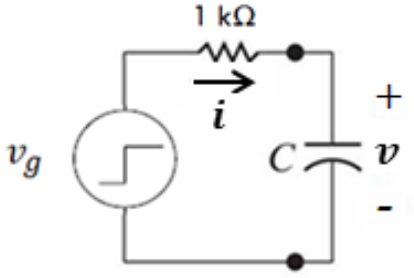
- Calculate the time constant when $R = 1\ 0\ \Omega$, $L = 10\ mH$, $L = 20\ mH$, and $L = 40\ mH$, respectively. Fill in Table 2. Refer to the above two graphs to find the time constant for RL circuits.
- Pulse waveform: A voltage pulse source can be applied using VPULSE element in PSpice. VPULSE has 7 parameters that are described and shown below.



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

Procedure

1. Open PSpice and construct a circuit shown below with a resistor of 1 kΩ and a capacitor of $1\mu F$. V_g is an independent voltage source generating square waveforms. Set $TR = TF = TD = 0,\ V_1 = 0, and\ V_2 = 10\ V$. 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

Table 1 Time Constant of RC Circuits

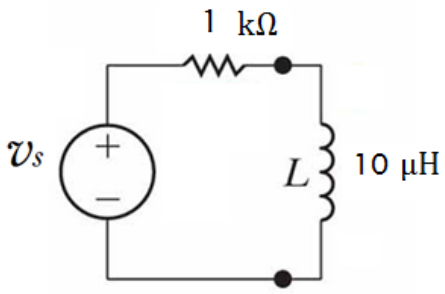
Resistance (kΩ)	Capacitance (μF)	Calculated Time Constant	Measured Time Constant
1	0.5		
1	1		
1	2		

What did you find? Why?

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

What is your minimum value of the capacitance to generate the triangle waveform output?

5. Construct a circuit shown below with a resistor of 10 Ω and an inductor of $10\ mH$. Set $TR = TF = TD = 0,\ V_1 = 0,\ V_2 = 10\ V$ 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

Table 2 Time Constant of RL Circuits

Resistance (Ω)	Inductance (mH)	Calculated Time Constant	Measured Time Constant
10	10		
10	20		
10	30		

Explain your results.

Questions and Conclusions

- Summarize your findings and explanations in response to the questions posed in this lab.