AMERICAN INTERNATIONAL UNIVERSITY–BANGLADESH (AIUB)
FACULTY OF SCIENCE & TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

ELECTRICAL CIRCUIT LAB - 6

SUMMER 2022-2023

Section: W, Group: 2

LAB REPORT ON

Transient Analysis of RC Series and RL Series using PSPICE

Supervised By

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Submitted By

Name	ID	Contribution
1. SK MUKTADIR HOSSAIN	21-44989-2	Precautions, Experimental Procedure, Simulation and Measurements, Apparatus
2. PRANTO BISWAS	21-45026-2	Theory and Methodology, Calculation, Simulation and Measurements
3. KAZI ABDULLAH JARIF	22-46386-1	Calculation, Discussion, Conclusion, Experimental Procedure
4. MD. NESAR UDDIN	22-46313-1	Precautions, Theory and Methodology, Conclusion, Apparatus

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Table of contents

Introduction: In this experiment we apply a pulse waveform to the RC and RL series circuit to analyze the transient response of the circuit by using PSPICE simulating tool. The pulse width relative to a circuit's time constant determines how it is affected by an RC and RL circuits.

The purpose of this experiment is to

1. simulate the circuits by using components from the PSPICE library and,
2. analyze obtained graphs and results

Theory and Methodology:

Time Constant (τ): A measure of time required for certain changes in voltages and currents in RC and RL circuits. Generally, when the elapsed time exceeds five-time constants (5τ) after switching has occurred, the currents and voltages have reached their final value, which is also called steady-state response.

The time constant of an RC circuit is the product of equivalent capacitance and the Thevenin resistance,

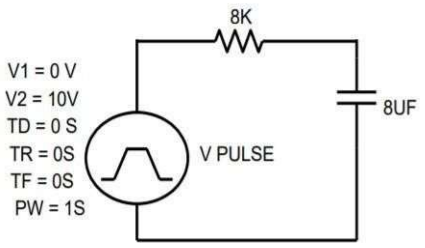
$$\tau = R \times C \qquad (1)$$

The time constant of an RL circuit is the equivalent inductance divided by the Thevenin resistance,

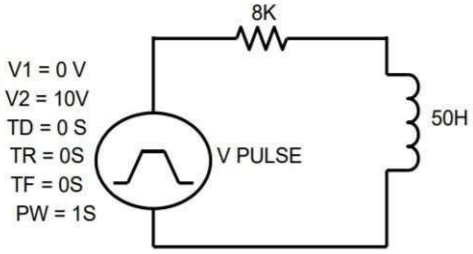
$$\tau = L/R \qquad (2)$$

Time Period (T): Time required to complete one cycle is called Time Period or the length of each cycle of a pulse train is termed its time period (T).

Pulse width (t_p): The pulse width of an ideal square wave is equal to half of the time period.



Figire-1: RC circuit



Figire2: RL circuit

Apparatus:

1. PC
2. PSPICE Simulating tools

Precautions:

Connecting of circuit should be done properly and PSPICE simulating software should be properly installed using the information provided at the manual before starting the experimental work.

Experimental Procedure:

1. Open the PSPICE Design Manager window: Start ❼ Program ❼ MicroSim Eval 8.
2. Open schematic editor: Press Run Schematics icon from the bar on the left side of the screen.
3. Select: Draw ❼Get New Part, then select and place each of the circuit elements one by one (VPULSE for pulse type voltage source, R for resistor, C for capacitor and EGND for ground). Join the elements by using the wire as necessary.
4. Change the label and magnitude of each element by double clicking on them and editing as necessary.
5. Then go to Analysis ❼ Setup ❼ Select Transient and provide the necessary Values. And select automatically Run Probe after Simulation.
6. To execute the analysis, select: Analysis ❼ Simulate or press F11. To view the analysis result select: Analysis ❼ examine output.
7. Select Analysis ❼ Simulate.
8. Select Trace ❼ Add and select the desired traces.
9. Perform the text analysis as instructed

Data Table:

For RC series circuit,

Time (t)	Percentage change	V_c (theoretical) (V)	V_c (readings) (V)
τ	63.2%	6.32	6.32
2τ	86.5%	8.65	8.65
3τ	95%	9.50	9.50
4τ	98.2%	9.82	9.82
5τ	99.3%	9.93	9.93

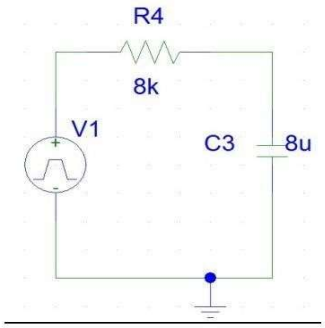
For RL series circuit,

Time (t)	Percentage change	I_L (theoretical) (μA)	I_L (readings) (μA)
τ	63.2%	126.4	126.4
2τ	86.5%	173	172.98
3τ	95%	190	190.06
4τ	98.2%	196.4	196.4
5τ	99.3%	198.6	198.7

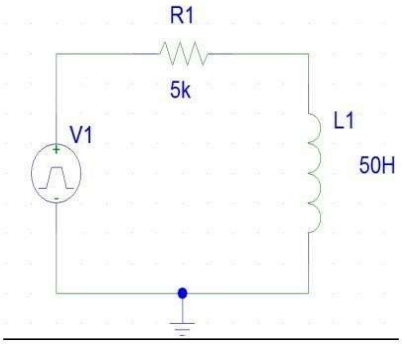
Simulation and Measurement:

In PSpice window, construct the virtual RC and RL circuits as shown below. Simulate the parametric wave shape for both the circuits. Compare the simulation results with your theoretical data and comment on the differences (if any).

RC Circuit:

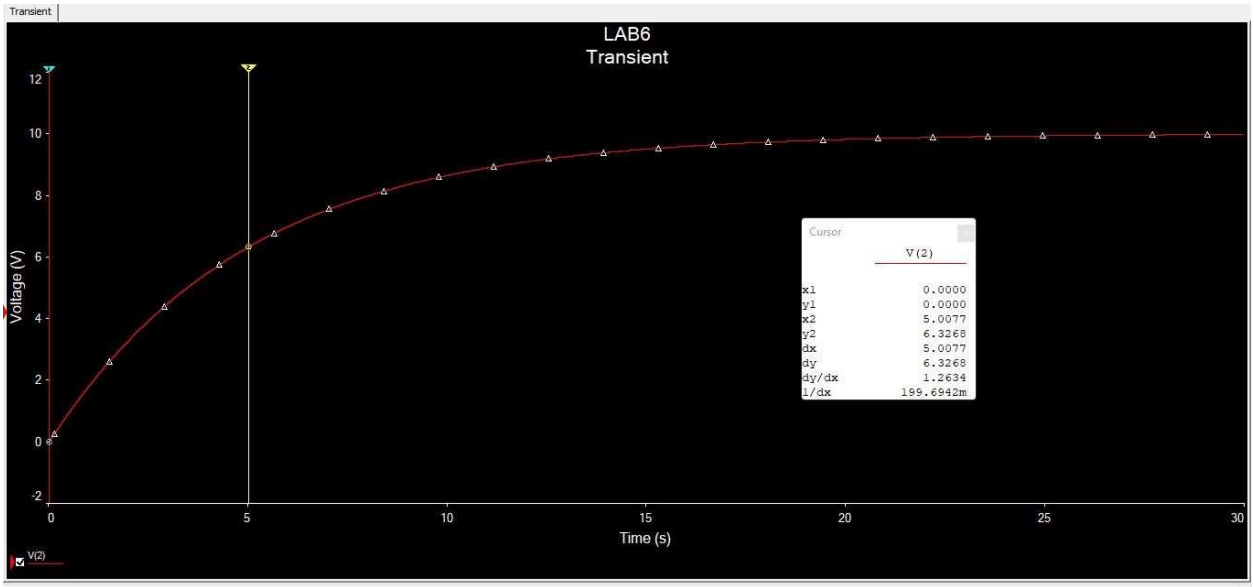


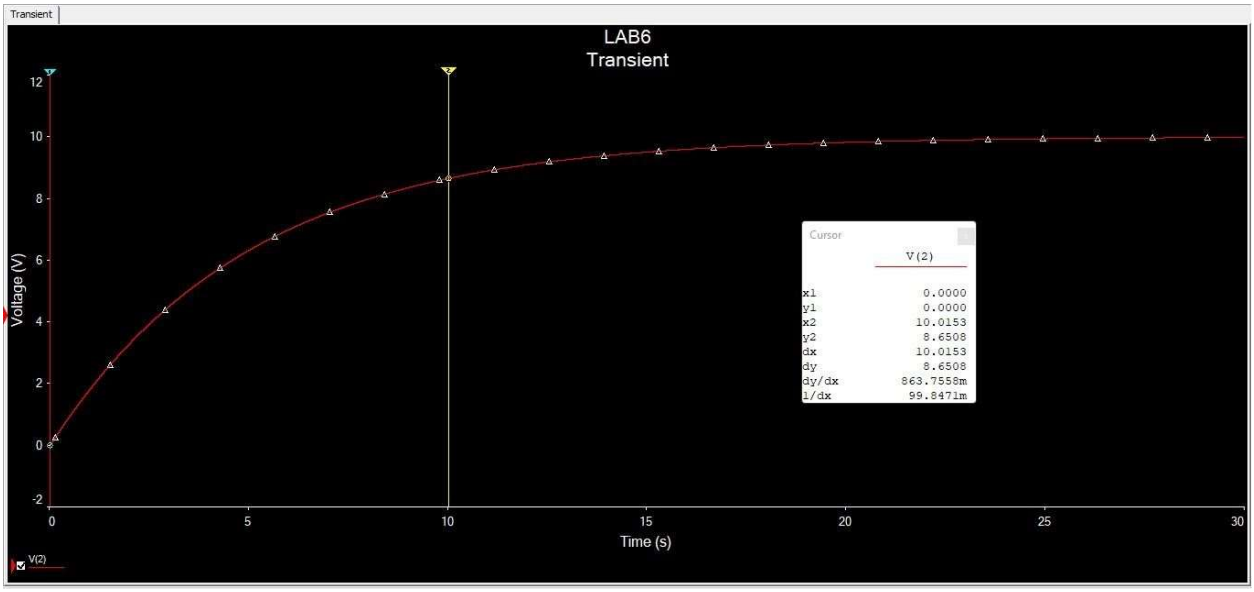
RL Circuit:

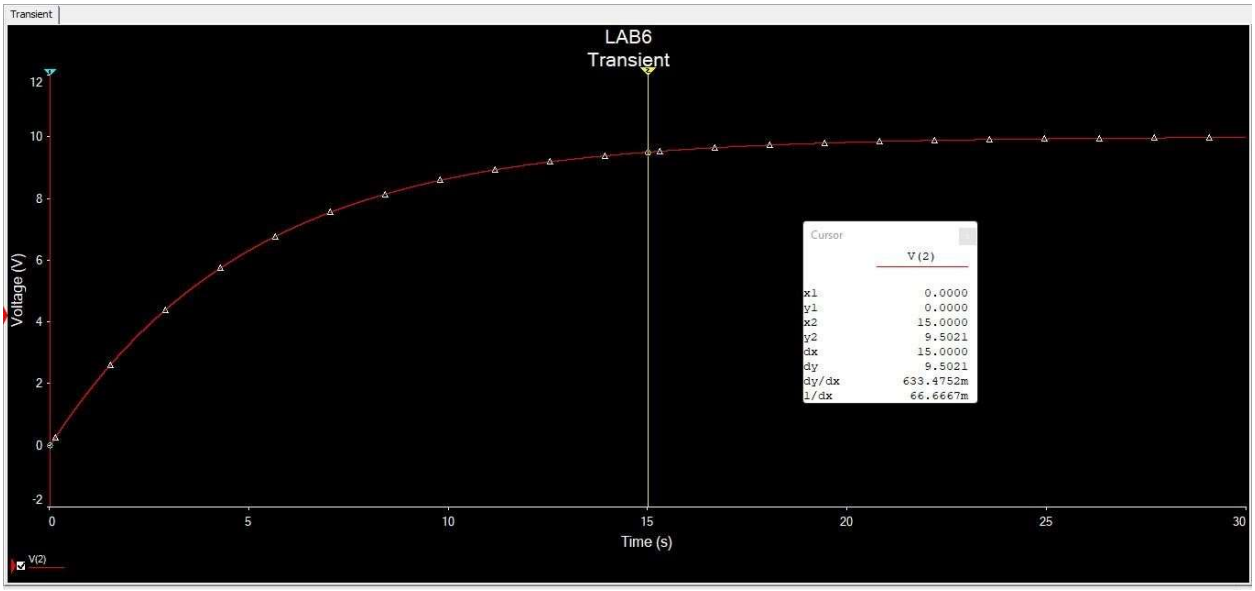


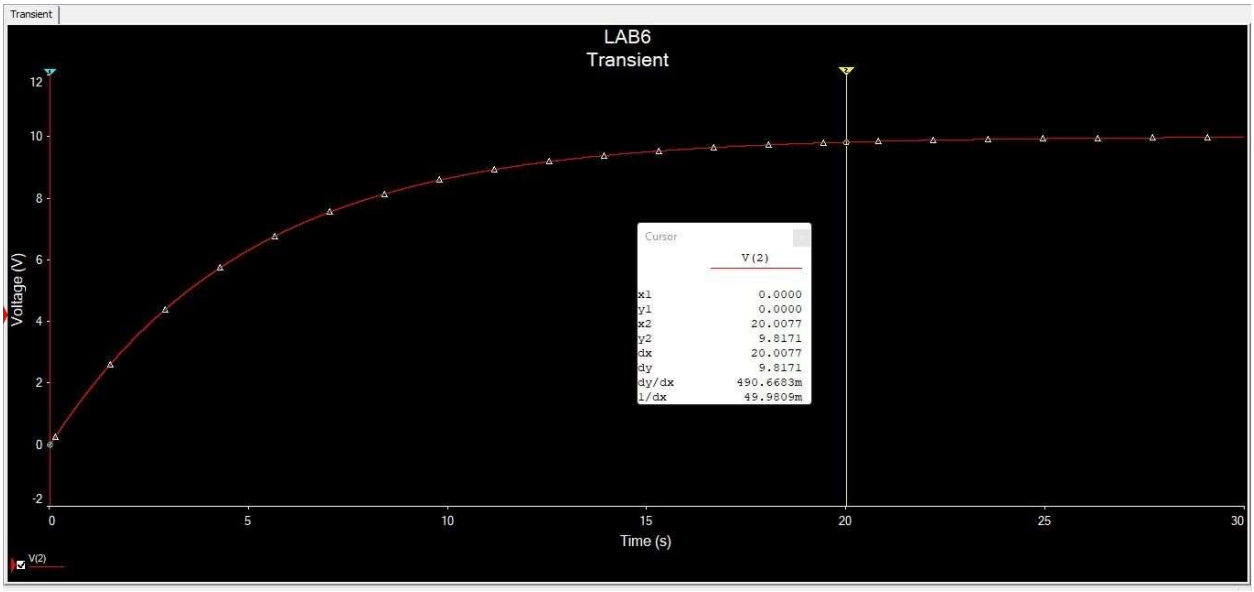
Sumilation:

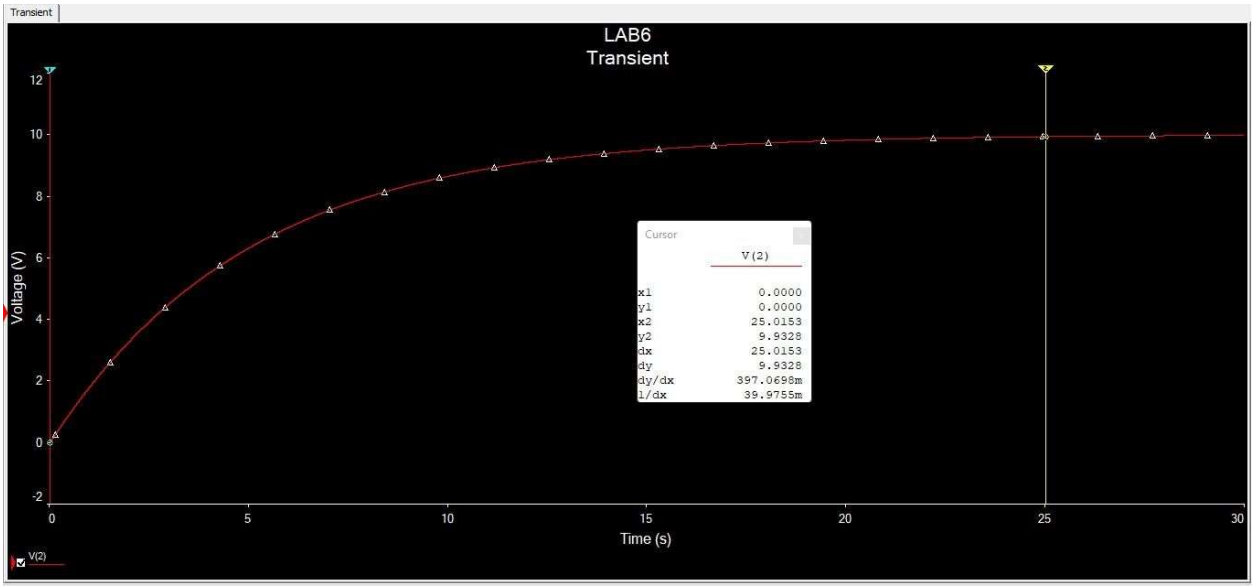
RC Circuit -



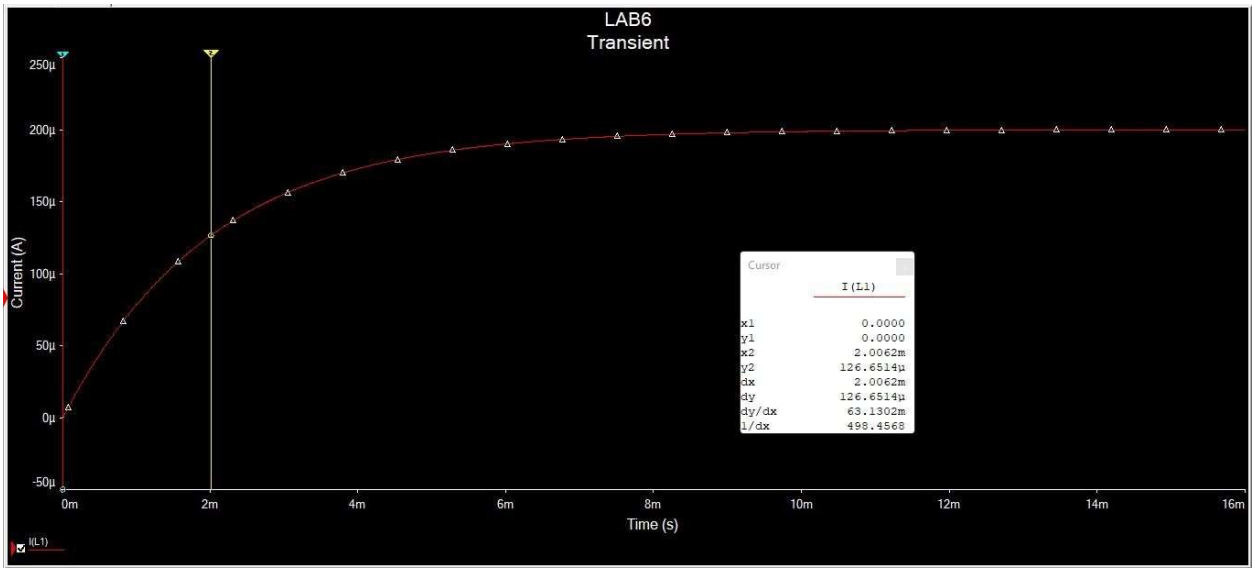

Transient
LAB6
Transient
Voltage (V)
Time (s)
Cursor
V(2)
x1 0.0000
y1 0.0000
x2 10.0153
y2 8.6508
dx 10.0153
dy 8.6508
dy/dx 863.7558m
1/dx 99.8471m
V(2)

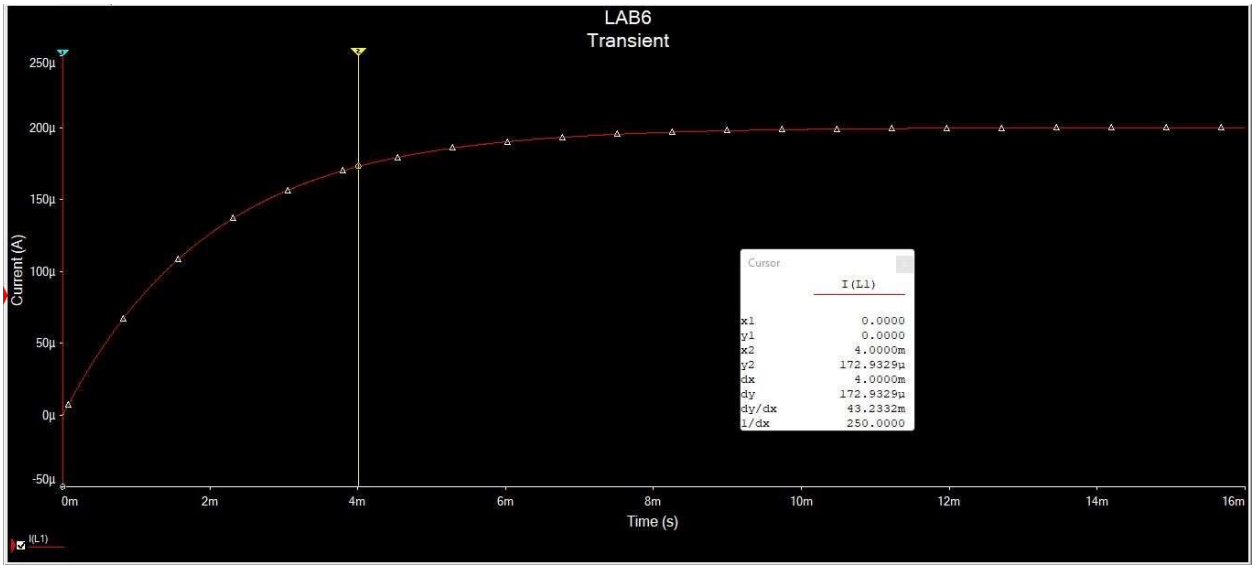

Transient
LAB6
Transient
Voltage (V)
Time (s)
Cursor
V(2)
x1 0.0000
y1 0.0000
x2 15.0000
y2 9.5021
dx 15.0000
dy 9.5021
dy/dx 633.4752m
1/dx 66.6667m
V(2)

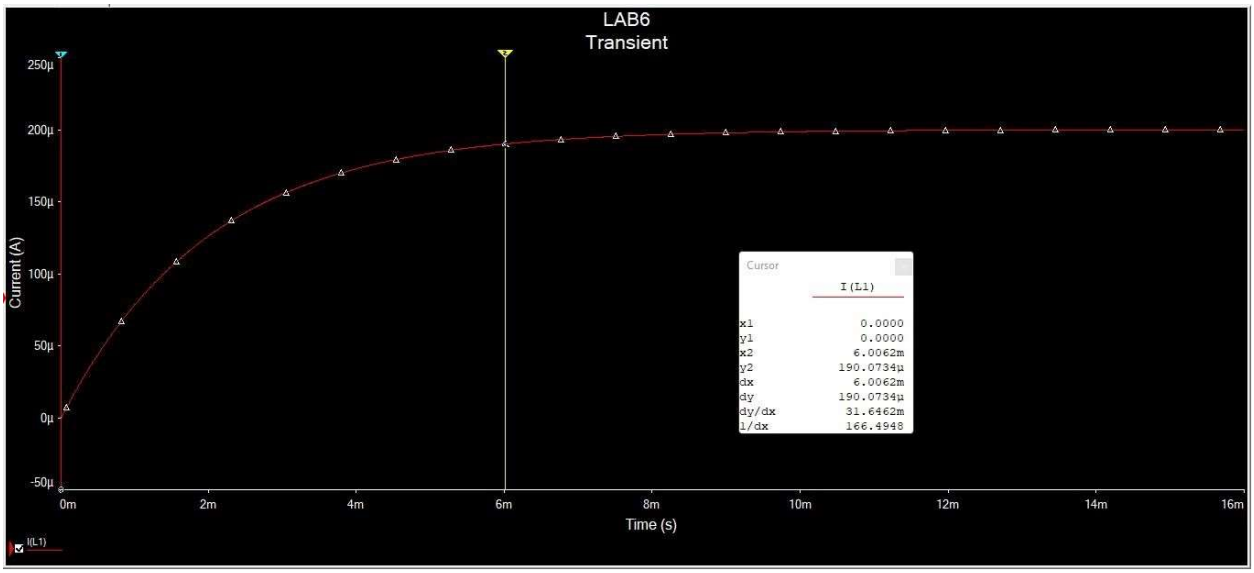

Transient
LAB6
Transient
Cursor
V(2)
x1 0.0000
y1 0.0000
x2 20.0077
y2 9.8171
dx 20.0077
dy 9.8171
dy/dx 490.6683m
1/dx 49.9809m
Voltage (V)
Time (s)
V(2)

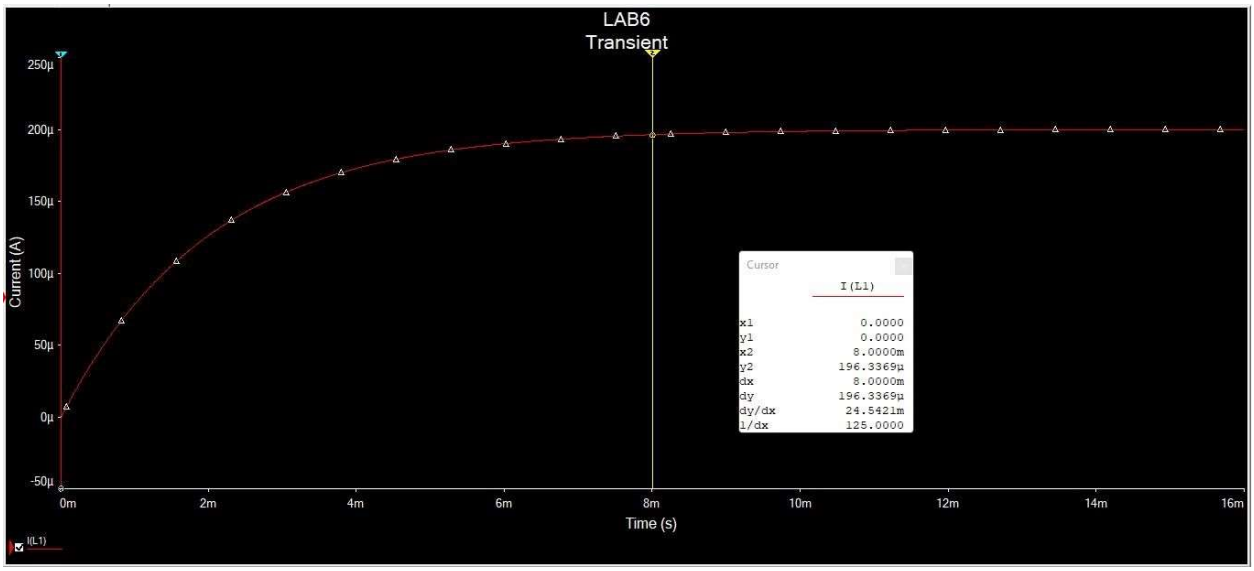

Transient
LAB6
Transient
Cursor
V(2)
x1 0.0000
y1 0.0000
x2 25.0153
y2 9.9328
dx 25.0153
dy 9.9328
dy/dx 397.0698m
1/dx 39.9755m
Voltage (V)
Time (s)
V(2)

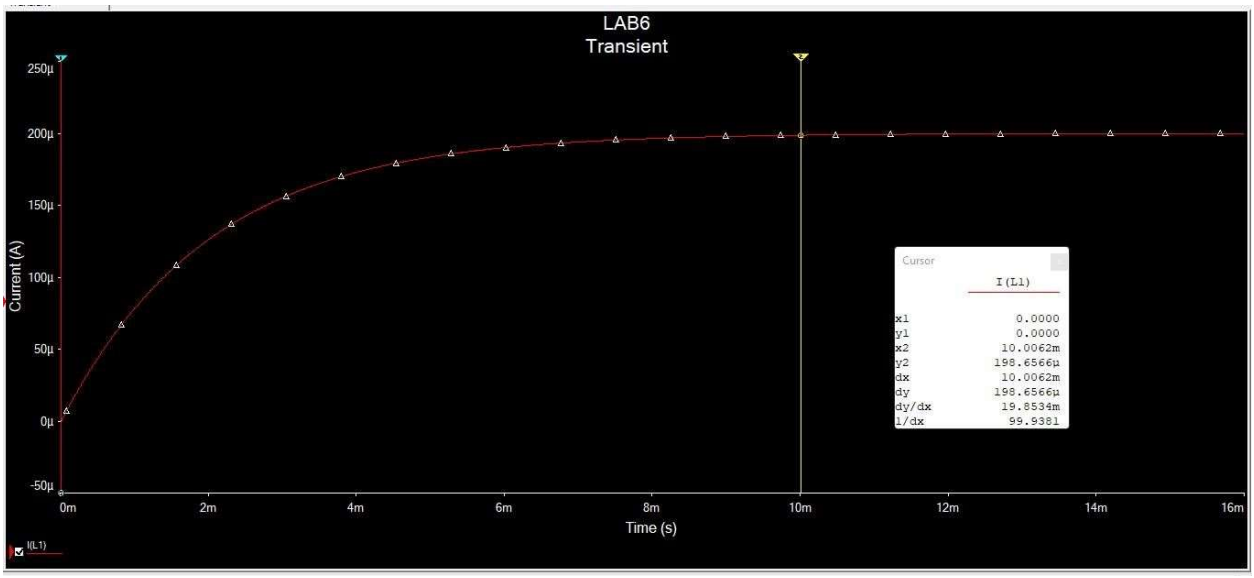
RL Circuit-


LAB6
Transient
250µ
200µ
150µ
100µ
50µ
0µ
-50µ
Current (A)
0m
2m
4m
6m
8m
10m
12m
14m
16m
Time (s)
I(L1)
Cursor
I(L1)
x1 0.0000
y1 0.0000
x2 2.0062m
y2 126.6514µ
dx 2.0062m
dy 126.6514µ
dy/dx 63.1302m
1/dx 498.4568


LAB6
Transient
250µ
200µ
150µ
100µ
50µ
0µ
-50µ
Current (A)
0m
2m
4m
6m
8m
10m
12m
14m
16m
Time (s)
I(L1)
Cursor
I(L1)
x1 0.0000
y1 0.0000
x2 4.0000m
y2 172.9329µ
dx 4.0000m
dy 172.9329µ
dy/dx 43.2332m
1/dx 250.0000


LAB6
Transient
250µ
200µ
150µ
100µ
50µ
0µ
-50µ
Current (A)
0m
2m
4m
6m
8m
10m
12m
14m
16m
Time (s)
I(L1)
Cursor
I(L1)
x1 0.0000
y1 0.0000
x2 6.0062m
y2 190.0734µ
dx 6.0062m
dy 190.0734µ
dy/dx 31.6462m
1/dx 166.4948


LAB6
Transient
250µ
200µ
150µ
100µ
50µ
0µ
-50µ
Current (A)
0m
2m
4m
6m
8m
10m
12m
14m
16m
Time (s)
I(L1)
Cursor
I(L1)
x1 0.0000
y1 0.0000
x2 8.0000m
y2 196.3369µ
dx 8.0000m
dy 196.3369µ
dy/dx 24.5421m
1/dx 125.0000



Theoretical Calculation:

Transiant analysis for RC series circuit:

Given $\mathcal{V} = 10V$

$R = 50 k\Omega$

$C = 100 \mu F$

we know, time constant, $\tau = RC$

$= 50 \times 10^3 \times 100 \times 10^{-6}$

$= 5$ sec

voltage accross equation,

$$V_c(t) = E\left(1 - e^{-\frac{t}{RC}}\right)$$

$$= E\left(1 - e^{-\frac{t}{\tau}}\right)$$

If $t = \tau$

$V_c = 10(1 - e^{-1})$

$= 6.32V$

If $t = 2\tau$

$V_c = 10(1 - e^{-2})$

$= 8.65$

if $t = 3\tau$

$V_c = 10(1 - e^{-3})$

$=$

if $t = 4\tau$

$V_c = 10(1 - e^{-4})$

if $t = 5\tau$

$V_c = 10(1 - e^{-5})$.

Transiant analysis for RL series circuit:

Given, $R = 50\ k\Omega$

$L = 100\ H$,

$E = 10\ V$

We know, steady state value, $I = \frac{E}{R}$

$= \frac{10}{50 \times 10^3}$

$= \frac{1}{5 \times 10^3}$

$= 201\ \mu A.$

time constant, $\tau = \frac{L}{R} = \frac{100}{50 \times 10^3}$

$= 2\,ms$

current $I_L(t) = \frac{E}{R}\left(1 - e^{-\frac{t}{\tau}}\right)$

if, $t = \tau$

$I_L(t) = \frac{10}{50 \times 10^3} \times (1 - e^{-1})$

$= 126.4\,\mu A.$

$t = 2\tau, \quad I_L(t) = 200\,(1 - e^{-2}) = 173\,\mu A$

$t = 3\tau, \quad I_L(t) = 200\,(1 - e^{-3}) = 190\,\mu A.$

Discussion:

1. The trainer board and the mutism software were checked beforehand.
2. The capacitor and the resistor were placed properly according to the figure.
3. Voltage across the capacitor for RC circuit and current across the RL circuit were calculated theoretically properly.
4. In the similar for technical issues in some points value was not sharply accurate.
5. At last, all the simulated values were placed in the data table

Conclusion: In this experiment, the value of theoretical and simulated was closely same which determine that the experiment was successful. The goal of the experiment was set of from the beginning. The study was described by calculating the voltage across the capacitor of RC circuit and current across of the inductor of RL circuit.

Reference(s):

1. Robert L. Boylestad," Introductory Circuit Analysis", Prentice Hall, 12th Edition, New York, 2010, ISBN 9780137146666.
2. R.M. Kerchner and G.F. Corcoran, "Alternating Current Circuits", John Wiley & Sons, Third Ed., New York, 1956.
3. Lamar University website, [Cited: 12.01.2014] Available: http://ee.lamar.edu/eelabs/elen2107/lab5.pdf
4. Lamar University website, [Cited: 12.01.2014] Available: http://ee.lamar.edu/eelabs/elen2107/lab6.pd