

Electrical Circuits II Lab 1 Online – RC and RL Step and Natural Response

Objectives

Apply LTspice to analyzing RL and RC circuits' natural and step response.

Preparation

In this and future labs, we will be using LTspice XVII developed by Analog Devices' Linear Technology group.

If you have not used LTspice recently, it is recommended to watch the following LTspice introductory videos from Electrical Circuits I course, before starting this lab:

- 1) Introduction to LTspice: <https://youtu.be/L1MONxRj9g4>
- 2) Dependent Sources: <https://youtu.be/Xuldvwfjm4k>
- 3) STEP Command and Charting: <https://youtu.be/86aXOFw7YQk>
- 4) DC Sweep simulation: <https://youtu.be/9o3Bc9mwz00>

Complete the following steps before starting work on this lab's experiments:

- 1) Review Natural and Step Response for RL and RC circuits – FEC Chap 7
(time constant: $\tau = R \cdot C$ for RC Circuit and $\tau = L/R$ for RL Circuit)
- 2) Watch Custom Waveform and Transient Simulation video at https://youtu.be/S9_4QgGR0J4

Experiment 1

Implement the following circuit in LTspice where $R = 1\text{k}\Omega$, $L = 10\text{mH}$ using V_{in} pulse shown:

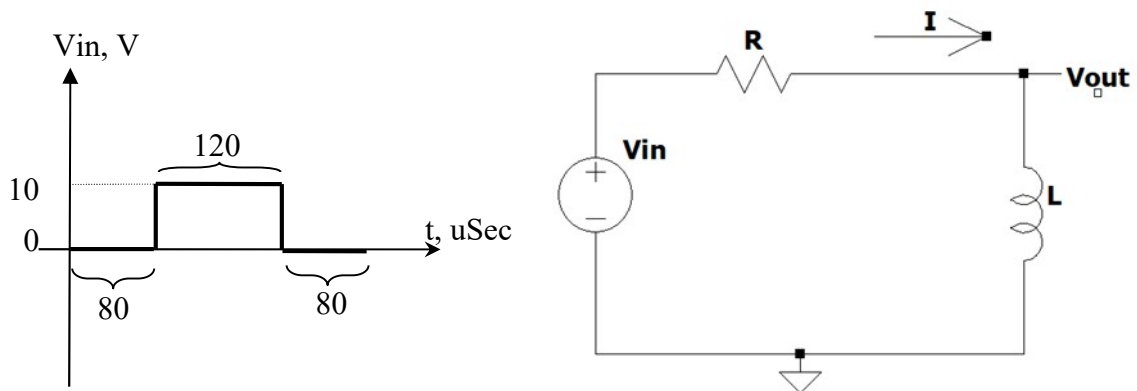


Chart V_{out} and I resulting from transient simulation of the circuit, create a table with the following information and explain any differences with theoretical values:

- 1) Step Response – present changes and values of V_{out} and I at one-, two- and three-time constant after the rising edge of pulse.
- 2) Natural Response – present changes and value of V_{out} and I at one-, two- and three-time constant after the falling edge of pulse.

Experiment 2

Repeat experiment one with new component values such that the time constant is equal to 27 μ Sec.

Experiment 3

Implement the following circuit in LTspice where $R=2\text{ k}\Omega$, $C=5\text{ }\mu\text{F}$ using V_{in} pulse shown:

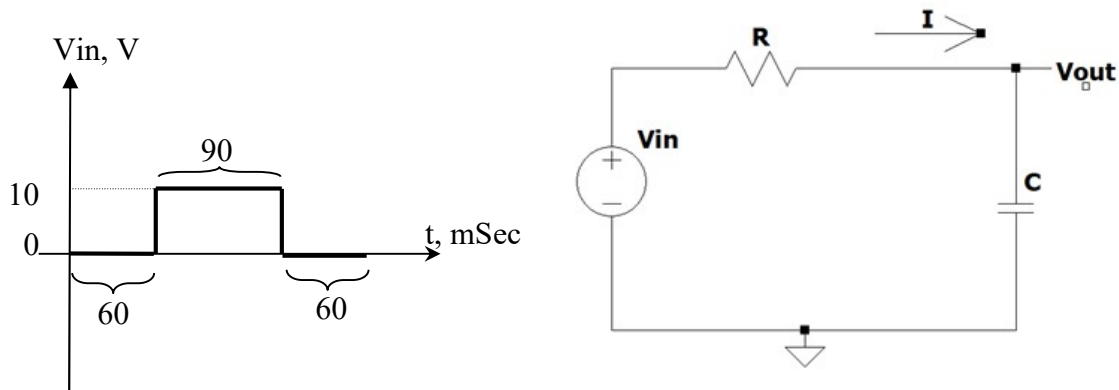


Chart V_{out} and I resulting from transient simulation of the circuit, create a table with the following information and explain any differences with theoretical values:

- 1) Step Response – present changes and values of V_{out} and I at one-, two- and three-time constant after the Rising edge of pulse.
- 2) Natural Response – present changes and values of V_{out} and I at one-, two- and three-time constant after the falling edge of pulse.

Experiment 4

Repeat experiment three with new component values such that the time constant is equal to 30 mSec.

Report Requirements

This lab and associated report must be completed individually. All reports must be computer printed (Formulas and Diagrams may be hand drawn) and at minimum:

For each experiment include:

- Clear problem statement in your words.
- Answer to any specific experiment questions (if any)
- Identify the theory or process and associated calculations
- Documents resulting circuit schematics from LTspice, simulation output and additional tables, timing diagram or chart required by the experiment.

For the whole report include:

- A Cover page with your name, class, lab and completion date.
- A Lessons Learned section which summarizes your learning from this lab in 5 sentences or more.
- A New Experiment section that has description of a new experiment and the experiment's results. Experiment should be related to material covered in class but not simply variation of the existing lab experiments.