York University
Dept. of Electrical Engineering and Computer Science

A laboratory Manual for Electric Circuits Lab EECS2200

Fall 2015-2016

ACKNOWLEDGEMENT

Prof Mokhtar Aboelaze developed this manual for EECS2200. Mr. Konstantin Bolshakov, who took this course in 2013, invested a lot of time and energy to improve this manual. Mr. Syed Islam updated this manual in Fall 2015.

PREFACE

This laboratory manual is intended for use in EECS2200 Electric Circuits. Every care was taken in preparing this manual, however no one is perfect. If you find any typos or errors in this manual, please contact the course director.

To the student:

The objective of this lab is to get you familiar with the instruments used in electric and electronic circuits measurements. It will introduce you to the concept of “lab book” and to how to design, implement and test simple electric circuits.

The lab will be done in groups of 2. Each lab consists of 2 parts. The prelab part will be done before you arrive to the lab. It will be submitted at the beginning of every lab. Then you have to do the experiment and record results. At the beginning of the next lab you should submit the lab report for the previous lab.

Each lab covers a specific topic in the course that will be clear from the lab title. It is your responsibility to read the theoretical part from the text book and the course notes before you go to the lab.

After you connect the circuit on the breadboard, check with the TA before connecting power. Please read the safety rules and troubleshooting hints before you start your first lab. Please be alert and use common sense during the experiment.

You have to maintain a laboratory book or journal, the TA must sign each page before you leave the lab. The journal will be checked once or twice during the term in order to be sure that you successfully did that part. Tips for maintaining a good journal are explained in this manual, please read “Appendix A: Laboratory Notebook” carefully.

The TA is there to help you, if you have any question ask the TA. A simple question might save you a lot of time and trouble later. Remember, you are dealing with expensive equipment.

To the TA:

Please read the experiment before you come to the lab. In the lab you have to approve the schematic diagram and the circuit connection before the students power up the experiment. Your job is to prevent any accidental mishaps that might injure students or destroy any equipment.

To the course Director:

The course director’s responsibility is to be sure that the lab is properly equipped, the TA is qualified to run the lab, the marked reports are returned to the students in a timely manner, and supervising the TA.

Lab 2: Thevenin's and Norton's Equivalent, RL and RC Circuits

OBJECTIVE:

- Learn how to construct Thevenin and Norton equivalents for any circuit.
- To verify Thevenin and Norton equivalents using the constructed circuits in the lab.
- Understand the charge and discharge of RC circuit.
- Learn how to measure the time constant of a circuit using an oscilloscope.

PRELAB:

- Please read the MDS3000 Oscilloscope Manual before attending the lab. This manual provides information on how to use oscilloscope and function generator.
- Calculate the Thevenin's and Norton's equivalent of the circuit shown in Figure L2.1 as seen by R_2.
- Find the voltage across the capacitor in Fig. L2.2 as a function of time if the capacitor was initially uncharged, and the switch was closed at time t=0.
- Using MATLAB or any other plotting program to plot the charging curve of the above capacitor (voltage vs. time).

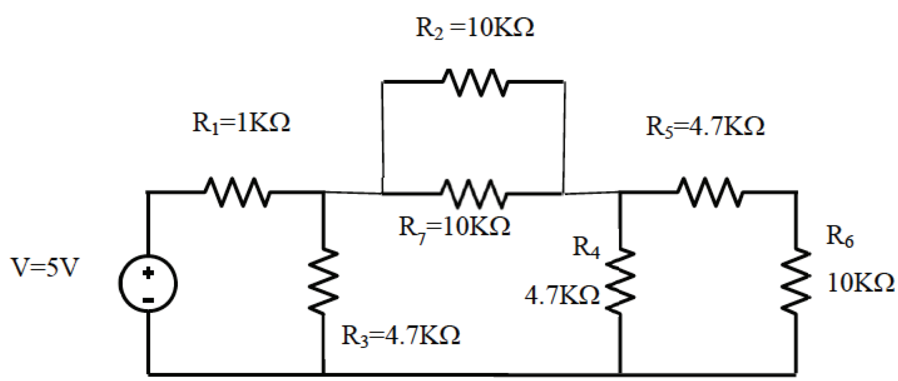

Fig. L2.1

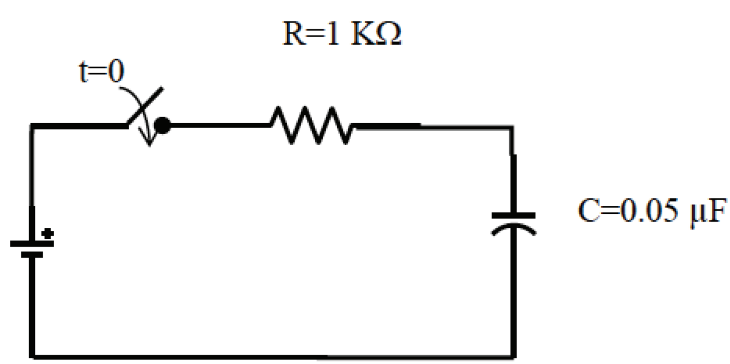

Fig. L2.2

LAB:

Part I Thevenin and Norton's Equivalent Circuits

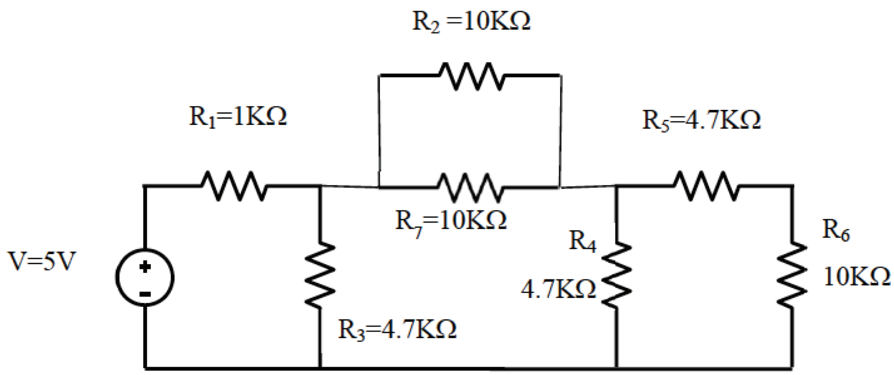

Fig. L2.1

In this part, you will construct a circuit based on Figure L2.1 to verify the Thevinin and Norton's equivalents. Please follow the following steps.

1. Choose the resistors based on values in Figure L2.1. Measure the actual values of the resistors and record these values.
2. Construct your circuit based on Figure L2.1 on a breadboard. Note that Thevenin equivalent circuit consists of a voltage source in series with a resistor. The voltage source equal to the open circuit voltage seen across the load resistor (R2 in the figure above). The series resistor is the resistance seen at the load after short circuiting the voltage source.
3. Disconnect the load resistor (R2) and measure the voltage seen at R2. This is the Thevenin voltage source.
4. Disconnect the load resistor, short circuit the voltage source and measure the current seen at the load output.
5. Construct the Thevenin equivalent circuit based on the values from Steps 3 and 4.
6. Measure the current in the load and the voltage across the load. Calculate the current in the load and the voltage across the load based on actual resistor values.
7. Compare the measured values with prelab values and values in Step 6.
8. Construct Norton's equivalent circuit based on values obtained in Steps 3 and 4. Measure the current in the load and the voltage across the load. Compare the measurements with those in Step 6. Note you need to set the power supply to current mode.

PART II

In this part, you will construct a circuit based on Figure L2.2 to understand the charge and discharge of a capacitor, and time constant. Please follow the following steps.

1. Choose the resistor and capacitor based on the values in Fig. L2.2. Construct the circuit based on a breadboard.

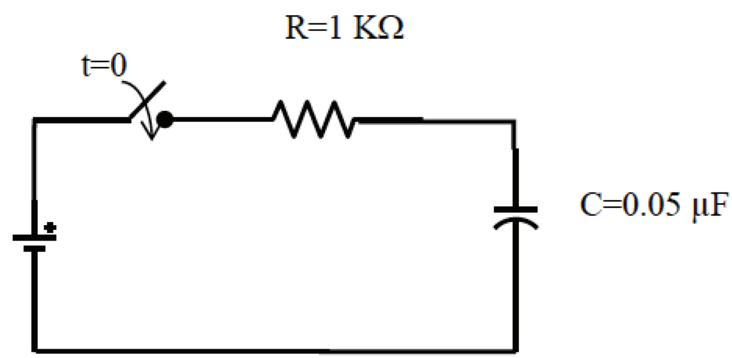

Fig. L2.2 A simple RC circuit

2. Let's investigate the response of a capacitor to a step function, i.e. closing the switch at time t=0. We can do that by displaying the voltage on the capacitor at the oscilloscope, then closing the switch. The only problem is that the charging of capacitor only takes few microseconds and you won't be able to see it on the oscilloscope. In order to observe the charging and discharging curves, we have to repeat the switching many times per second, i.e., the switch should be closed, opened, and then closed again and again for many times per seconds. Instead of using a DC power supply and a switch, we replace them by a 2V square wave generated from the Signal Generator. The output of Signal Generator is similar to the waveform in Fig. L2.3.

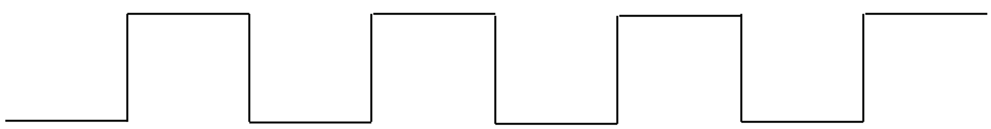

Figure L2.3 A square wave

If the high time (time in which the signal is 2V) is more than 5 τ (τ=RC= time constant) we can assume that the capacitor is charged to 2V. Use the functional generator to generate a square wave with a frequency of 5 KHz.

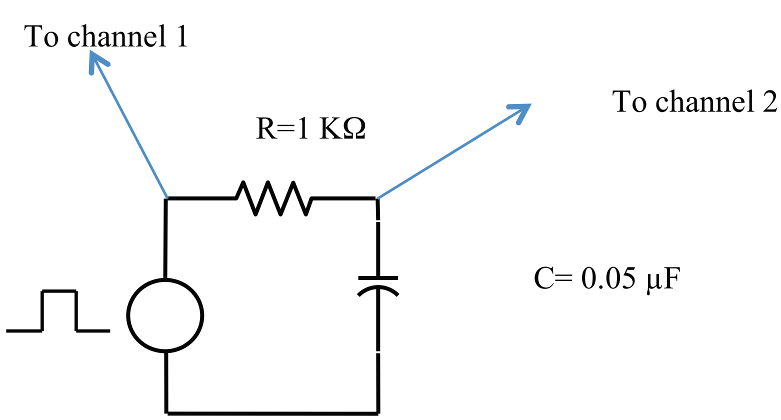

Figure L2.4 A simple RC circuit with a square wave input

3. Use the oscilloscope to display the voltage across the capacitor and the input voltage.

4. Sketch the waveform (voltage across the capacitor) in your notebook for a complete cycle recording the voltage and time (at least 5-6 different points within a cycle).
5. What is the value of the voltage compared to an ideal step function (as calculated in prelab)? Are there any differences between measured values and an ideal step function (as calculated in prelab)?
6. From the display, find the time at which the signal reaches 0.37 from its maximum value. Compare this with the calculated time constant.
7. What frequency (square wave) that makes the circuit response close to an ideal step function?
8. Shunt the capacitor with another 1 KΩ resistor. What should be the time constant of the circuit? Display the result on the oscilloscope and show it to your TA. What frequency would make this circuit close to an ideal step function.

Part III

In this part, you will construct a circuit based on Figure L2.5 to understand the step response of an RL circuit. Please follow the following steps.

1. Construct the circuit in Fig. L2.5. Generate a square wave as you did in Part II, choose the frequency such that the circuit will reach the steady state in every cycle twice (once for the charging and one for the discharging). What is the frequency you chose?

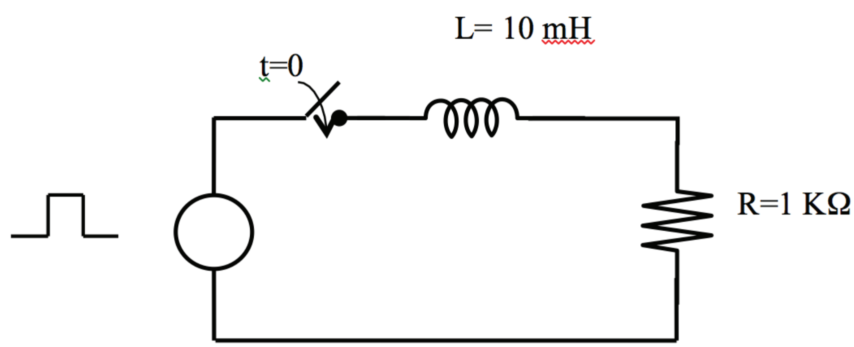

Fig. L2.5 A simple RL circuit

2. Use the oscilloscope to display the voltage across the resistor and the input voltage. Sketch the display in your lab notebook and show it to the TA.