Electrical Circuits LAB #4 - Kirchhoff's Laws and Fault Detection

Objectives

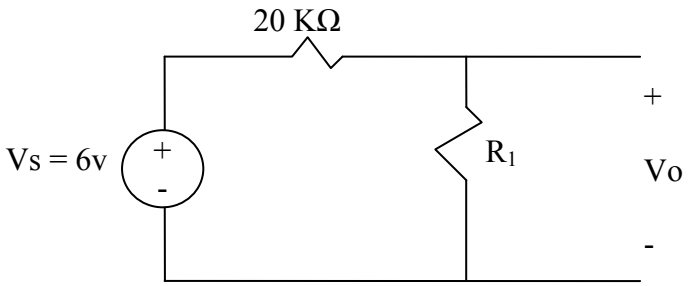
Understand and apply Kirchhoff's Laws and Fault Detection techniques

Material

- Textbook: Electrical Circuits by Nilsson & Lecture material
- www.EngrCS.com
- Instruments: Power Supply & Multimeter
- Supplies:
  - Electrical Tool Box
  - Proto Board
  - Power Extension, probes & Connecting Cables
  - 3 red LED
  - Available Resistors

Experiment 1

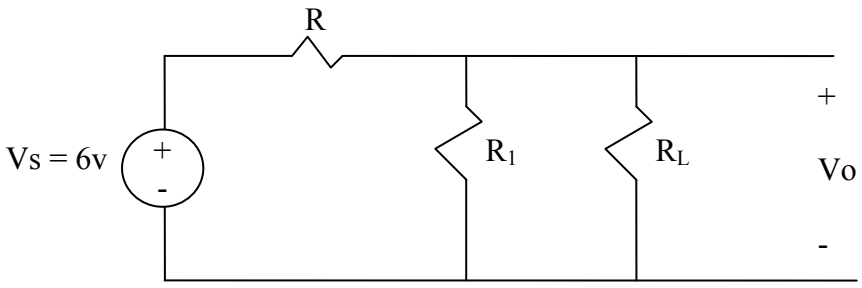
a) For the following circuit, calculate the value of R_1 such that Vo equals 0.25 Volts.



b) Select a single resistor from the available fixed-value resistors in the lab to achieve the desired voltage Vo specified in section (a). Calculate the percent of Vo deviation from the calculated value and explain its relationship to the percent of difference between selected resistor value and the calculated resistance value.

c) Identify and explain three approaches to reduce the percent deviation of the measured value from the calculated value of Vo, using only the available components in the lab.

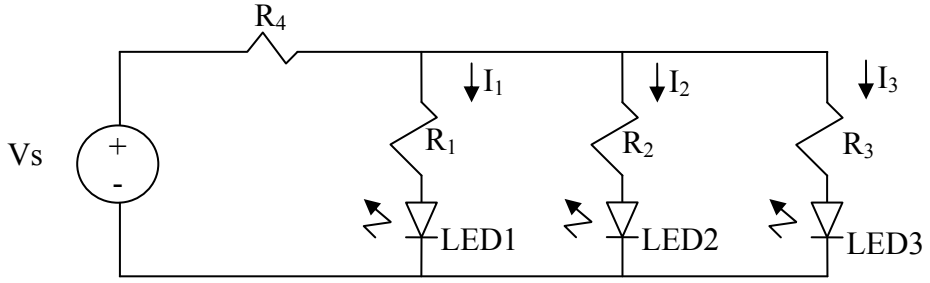
d) Derive an equation for the value of R in terms of R_L such that Vo = 3 volts with the value of R_1 from part (a), as R_L changes in the following circuit. Show your calculations.



e) Implement the circuit designed in section (d) for R_L = 10 KΩ. Calculate and measure the resulting current. Explain any variation from the calculated value. Show data to support your explanation.

Experiment 2

a) Select values of the components in the following circuit such that I_1 = 2.5 mA, I_2 = 5 mA and I_3 = 7.5mA. Assume that each LED has a voltage drop of 1.7 Volts in the forward direction.
Hint: You have flexibility in selecting the exact value of Vs and resistors, but the ratios are fixed by the value of currents.

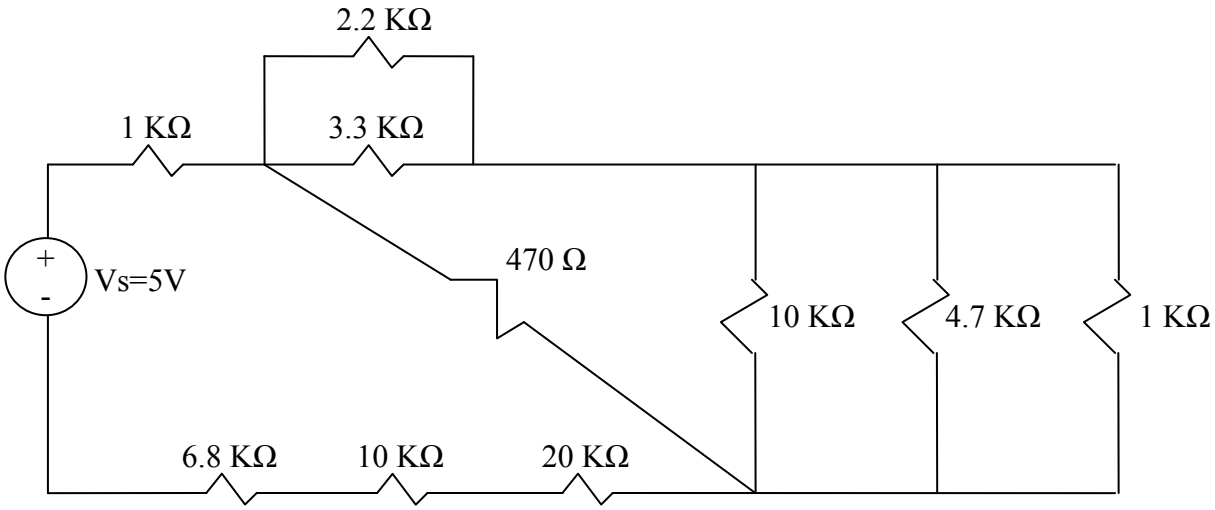


b) Implement the circuit with values selected in section (a) and measure the actual value of I_1, I_2, I_3. Explain any differences between expected value and measured value of I_1, I_2, I_3.

Experiment 3

Electrical Circuits may fail due to design flaws, manufacturing issues, component failures or operational stresses. For example, a failure due to a single fault may occur when a single resistor is either shorted (R=0) or opened (R=∞). Multiple faults can occur, when multiple failures occur at the same time. Typically, a single failure will cause stress on other components, resulting in multiple fault condition. For this experiment, only resistors can fail.

Answer the listed questions for the following circuit:



a) Identify a single fault that would result in maximum supply current. Calculate the maximum value of supply current resulting from the identified single fault. For this fault, measure the value of maximum source current. Explain any variation from the calculated value. Show data to support your explanation.

b) Identify a single fault in this experiment's original circuit such that maximum current flows through the 4.7 KΩ resistor. Calculate and measure the resulting current. Explain any variation from the calculated value. Show data to support your explanation.

c) Identify a double-fault in this experiment's original circuit such that maximum current flows through the 4.7 KΩ resistor. Calculate and measure the resulting current. Explain any variation from the calculated value. Show data to support your explanation.

Report Requirements

Reports must be prepared individually even if the experiments are performed as a team. All reports must be computer printed (formulas and diagrams may be hand drawn) and at minimum:

For each experiment include:

a) Clear problem statement; specify items given and to be found
b) Theory and process used
c) Resulting circuit diagram, tables, graphs, calculations and other results

For the overall report include:

a) Cover sheet with your name, lab, date of completion and team members' names
b) Lessons learned from this lab
c) A new experiment and expected results which provide additional opportunity to practice the concepts in this lab