



Analysis and Measurement of a Resistor Bridge Circuit with Three Voltage Sources

EL 111 - DC Fundamentals — Required Laboratory Project

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INTRODUCTION

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The ability to analyze a complex circuit is an important skill for anyone who designs or analyzes circuits to have. One very powerful tool for analyzing complex circuits is **mesh analysis**, which is based on Kirchhoff's voltage law: the algebraic sum of the voltage rises and drops around a complete loop is zero.

Mesh analysis is a structured approach that you have learned in lecture. "Loop equations" are written for the "**N**" current loops in the circuit, producing "**N**" simultaneous linear equations. Once these loop equations are written, they can be solved easily using **Cramer's Rule** (with determinants). When the loop currents are found, the current through each element and the voltage across each element can be found.

In this laboratory project, you will use **mesh analysis** to "solve" a bridge circuit which contains three independent voltage sources, simulate it with computer software, and measure it.

PROCEDURE (Note: _ below means check with instructor AFTER this step)

- 1) select and measure resistors for your circuit (see Fig. 1). This is important to do first, so that your calculations (step 3) and your computer simulation (step 4) will be based on the actual resistance (which is never the same as the (color-) coded resistance. Record the measured resistance values on Fig. 1, **and create a table that will be used to record data from procedure steps 3, 4, 6.**
- 2) use mesh analysis to calculate all circuit currents. Call your currents I_A , I_B , and I_C .
- _3) having determined all mesh currents, calculate the current through (magnitude & direction) and the voltage (magnitude & polarity) across each resistor. Record all currents & voltages on Fig. 2, and in the table you created in step 1.
- _4) perform a computer simulation of the circuit using SNAP, SPICE, PSpice®, or other software package approved by your instructor, and use the results of the computer simulation to find the current through (magnitude and direction) and the voltage (magnitude and polarity) across each resistor. Record all currents and voltages on Fig. 3, and in the table you created in step 1. Print the simulation, and submit it with this report.
- 5) build the circuit in lab (**make sure** to use the same resistors that you selected and measured in step 1), and turn on the power supplies.
- _6) measure the voltage across each resistor in your circuit, and record those voltages (with polarity) on Fig. 4. Now, using these measured voltages, calculate the current through each resistor. Record these currents (magnitude and direction) on Fig. 4 as well. Also, record voltages and currents in the table you created in step 1.
- _7) **prepare three schematic diagrams, similar to Fig. 1, so that each one shows how to connect the ammeter to measure one of the three mesh currents.** Now measure the "mesh" currents



IA, IB, and IC (see step 2). Record these *measured* currents (magnitude and direction) on Fig. 4. Also, complete Table I.

Table I

Mesh Current	measured current (amp)	calculated current (amp)	Error (%)
IA			
IB			
IC			

- 8) replace the 1kΩ bridge resistor (R_{BRIDGE}) with resistors with coded values of 100 Ω, 200 Ω, 510 Ω, 1k Ω, 2k Ω, 5.1k Ω, 10k Ω, 15k Ω, and 20k Ω, one at a time. For each value of R_{BRIDGE} resistor, measure the actual resistance, and voltage across the resistor, and record the data in the Table II.
- _9) for each value of R_{BRIDGE} in step 8, calculate the power dissipated by R_{BRIDGE} , and record it in Table II.
- 10) construct two neat, accurate, carefully plotted graphs of resistor power versus resistance, using the data in Table II. One should be on linear paper, and the other on 3-cycle semi-log paper (R_{BRIDGE} is the log axis variable). **See sample graphs provided by your instructor for models of how to make the graphs.**

Table II

coded R_{BRIDGE} (Ω)	measured R_{BRIDGE} (Ω)	Voltage (volts)	Power (watts)
100			
200			
510			
1k			
2k			
5.1k			
10k			
15k			
20k			

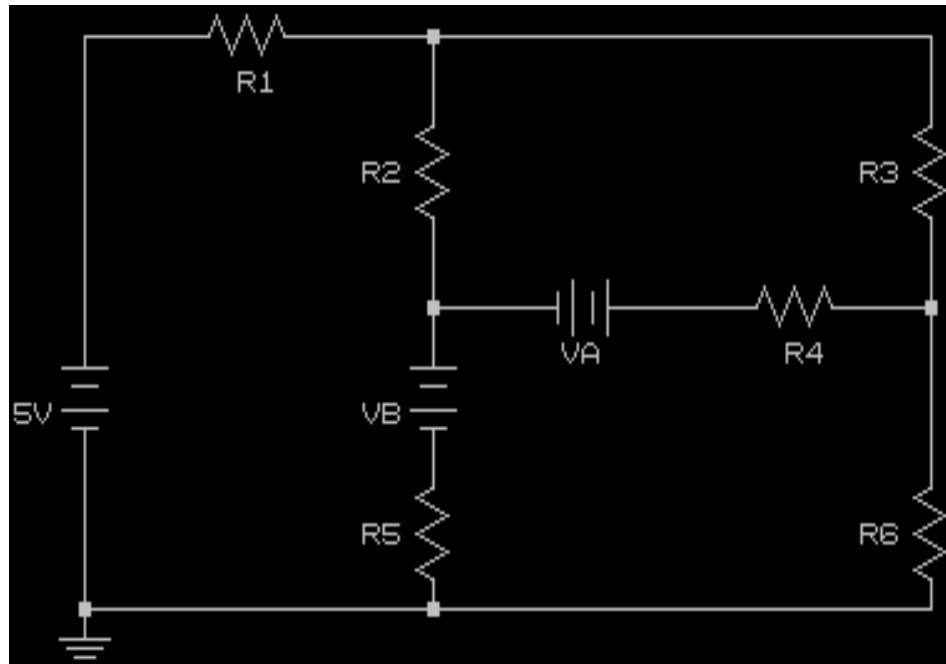


Figure 1 - Record MEASURED Resistor Values Above

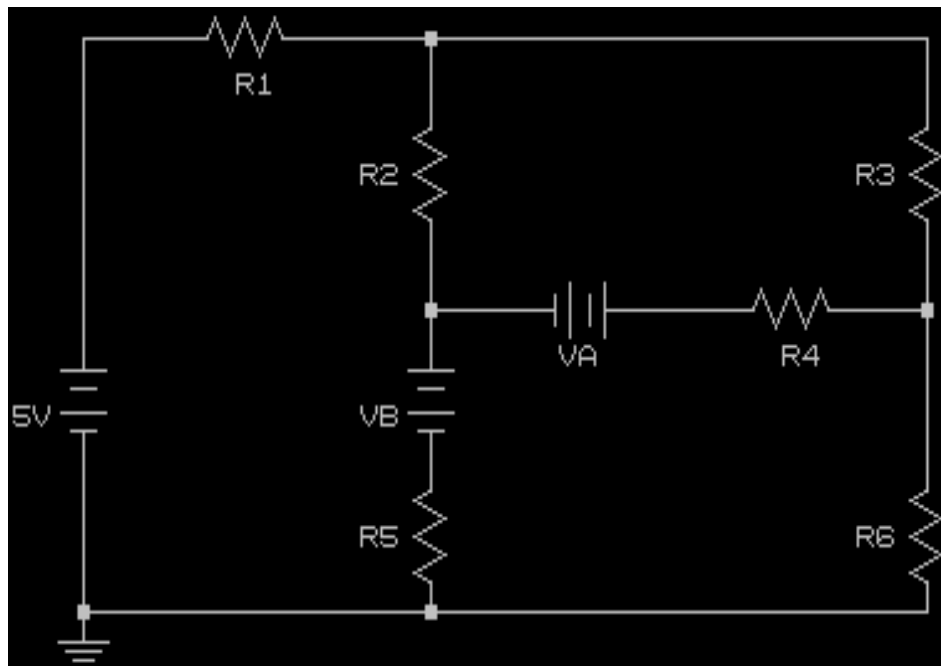


Figure 2 – Record CALCULATED Resistor Voltages & Currents Above

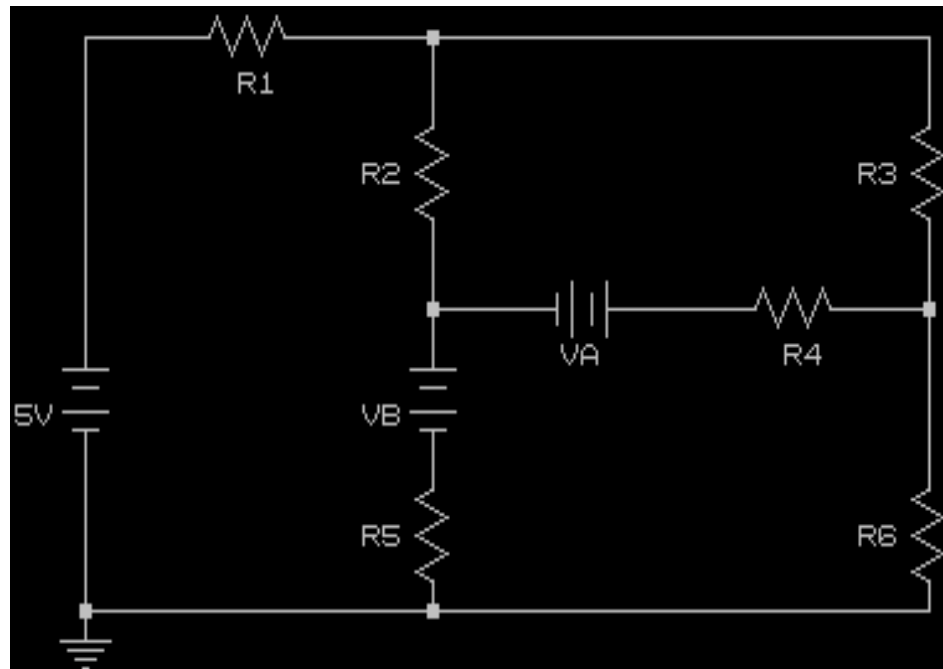


Figure 3 - Record **COMPUTER SIMULATION** Resistor Voltages & Currents Above

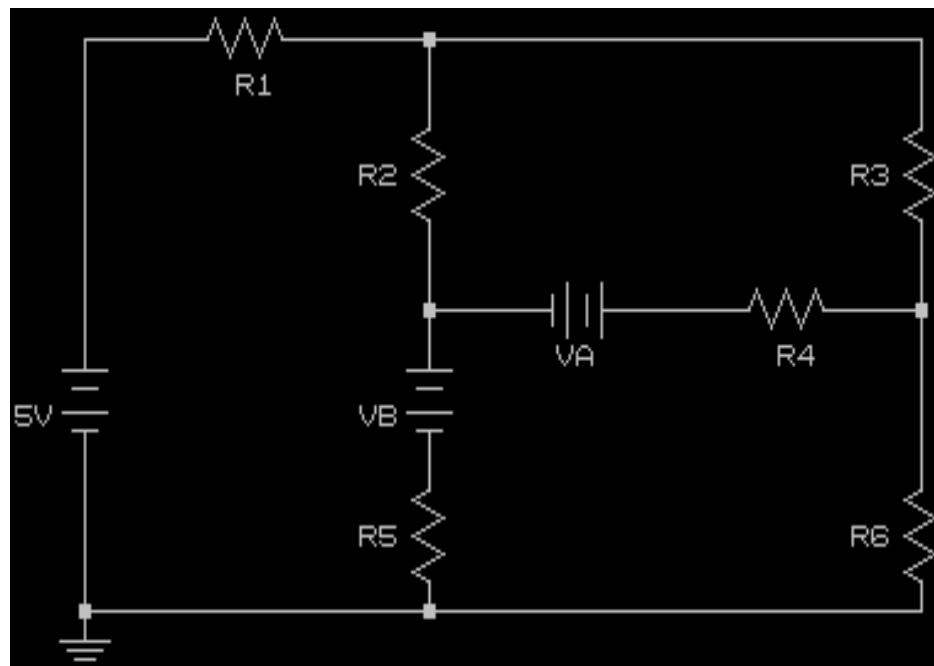


Figure 4 - Record **MEASURED** Resistor Voltages & Calculated Currents Above



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Individual Student Part Values Assignment Sheet for:

PARTS VALUE ASSIGNMENT:

R4 = 1k Ω

R1	Ω
R2	Ω
R3	Ω
R5	Ω
R6	Ω
VA	Volts
VB	Volts