Pre-Lab #2

Wheatstone Bridge

Barış DEMİRCİ agu@338.rocks

April 23, 2024

Contents

1 Overview **3**

2 Pre-Lab Task **4**
2.1 LTspice Simulation 4
2.2 Theoretical Analysis 5
2.3 Numerical Verification 6

3 Conclusion **7**

Chapter 1

Overview

The purpose of this pre-lab report is to prepare for Laboratory Work #2 in the ESD Capsule. This lab aims to introduce the Wheatstone Bridge and its applications. The Wheatstone Bridge is a circuit that is used to measure an unknown resistance by balancing two legs of a bridge circuit. The Wheatstone Bridge is a fundamental circuit in electrical engineering and is used in many applications such as strain gauges, thermistors, and potentiometers. This lab will also introduce the concept of a potentiometer and its applications.

Chapter 2

Pre-Lab Task

2.1 LTspice Simulation

We have simulated the Wheatstone Bridge circuit in LTspice. The circuit is shown in Figure 2.1. The simulation results are shown in Table 2.1. The simulation results show that the output voltage is zero when the bridge is balanced. The output voltage increases as the bridge becomes unbalanced.

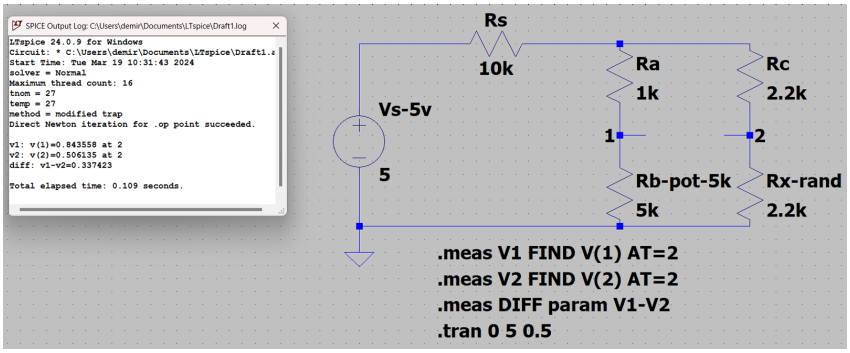

Figure 2.1: LTspice simulation of the Wheatstone Bridge

For $R_x = 2.2$k		For $R_x = 1$k	
R_b	V_{12}	R_b	V_{12}
1k	0	1k	0.10274
2.2k	0.146536	2.2k	0.258621
3k	0.216535	3k	0.330189
4k	0.284483	4k	0.397959
5k	0.337423	5k	0.44964

Table 2.1: LTspice simulation results of the Wheatstone Bridge circuit

2.2 Theoretical Analysis

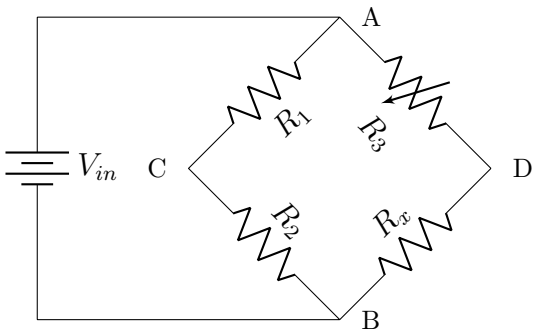

Figure 2.2: Wheatstone Bridge circuit

Let's try to derive Wheatstone balance equation to find R_x:

$$V_{out} = V_C - V_D = V_{R_2} - V_{R_x} = 0$$

$$R_C = \frac{R_2}{R_1 + R_2} \quad \text{and} \quad R_D = \frac{R_x}{R_3 + R_x}$$

$$\text{At balance,} \quad R_C = R_D$$

$$\frac{R_2}{R_1 + R_2} = \frac{R_x}{R_3 + R_x}$$

$$R_2(R_3 + R_x) = R_x(R_1 + R_2)$$

$$R_2R_3 + R_2R_x = R_xR_1 + R_xR_2$$

$$R_2R_3 = R_xR_1$$

$$R_x = \boxed{\frac{R_2R_3}{R_1}}$$

2.3 Numerical Verification

If we try to verify the Wheatstone balance equation, we can create the following circuit diagram according to the results on the LTspice result table 2.1:

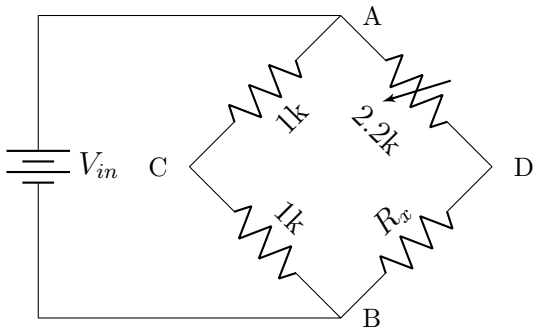

Figure 2.3: Wheatstone Bridge circuit

If we apply the balance equation (Where $V_{CD} = 0$) we can find the value of R_x which should be $2.2k$ according to LTspice result:

$$R_x = \frac{R_2 R_3}{R_1}$$
$$R_x = \frac{1k \times 2.2k}{1k}$$
$$R_x = 2.2k$$

The experimental results are consistent with the theoretical results.

Chapter 3

Conclusion

In this pre-lab report, we have simulated the Wheatstone Bridge circuit in LTspice. We have also derived the Wheatstone balance equation and verified it experimentally. The results show that the output voltage is zero when the bridge is balanced. The output voltage increases as the bridge becomes unbalanced. The experimental results are consistent with the theoretical results.