University of California Merced
School of Engineering
Department of Electrical Engineering

ENGR 065 Circuit Theory

Lab 4: Series and Parallel Circuits and the Node Voltage Method

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Objectives

- Familiarize with breadboards by constructing more complex circuits
- Analyze series-connected and parallel-connected circuits
- Study and verify node-voltage methods

1. Introduction

In the lab, students must have been able to distinguish the difference between the parallel circuits and the circuits in series. In doing so, students must construct a circuit using a breadboard and measure the currents and voltages. A parallel circuit has the same voltage throughout the circuit while a circuit in series has the same current through the circuit. Equivalent resistance for a circuit in series is: Req= R1 + R2, while circuits in parallel is:

$$Req = (1/R1) + (1/R2) + \ldots (1/Rn)$$

2. Methods & Procedures

The equipment needed for this lab consists of a breadboard, wires, resistors, AC/DC power source, and a multimeter. Before doing the lab, students must calculate the equivalent resistance, current, and voltage of **Figure 1**. Once calculated, construct a circuit using a breadboard mirroring **Figure 1** and apply 10 V to the circuit. Measure the voltage and current and record data for **Table 1**. Construct a circuit that mirrors the circuit in **Figure 2**, and measure the voltage and record data in **Table 2.**

Figure 1

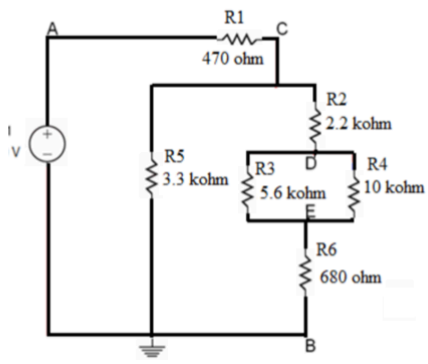
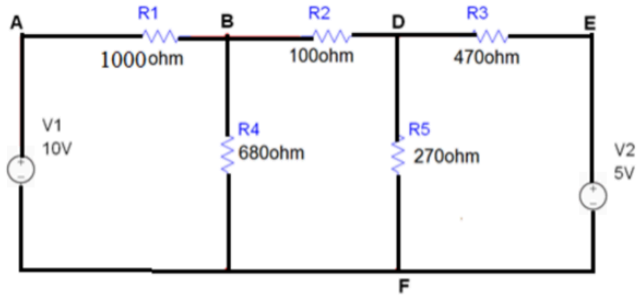


Figure 2



Analysis of Data:

Table 1:

Variable	Theoretical Value*	Measured Value
I_{R1}	3.77 mA	3.59 mA
I_{R2}	1.27 mA	1.21 mA
I_{R3}	0.82 mA	0.77 mA
I_{R4}	0.46 mA	0.44 mA
I_{R5}	2.49 mA	2.36 mA
I_{R6}	1.27 mA	1.22 mA

Variable	Theoretical Value*	Measured Value
V_A	10 V	10.19 V
V_B	0 V	0 V
V_C	8.23 V	8.38 V
V_D	5.44 V	5.59 V
V_E	0.86 V	0.89 V

Variable	Theoretical Value*	Measured Value
V_{AC}	1.77 V	1.80 V
V_{CD}	2.79 V	2.77 V
V_{DE}	4.58 V	4.67 V
V_{EB}	0.86 V	0.89 V
V_{CE}	7.37 V	7.47 V

Looking at **Figure 1** and the recorded values in **Table 1**, students found answers to the lab protocol. It is observed that if **R1** is open circuited and removed, it would make **V_D (Node D)** have a voltage of zero. Since **R1** becomes an open circuit, it creates a disconnection and there is no voltage that will go through to **Node D.** Now if **R6** becomes an open circuit, **Node D** will equal **Node C** for the circuit constructed in **Figure 1.** If **R5** becomes an open circuit, the current in **R1** will increase.

Table 2:

Symbol	Measured Value (V)
V_{AB}	7.3
V_{BD}	.32
V_{DE}	3.52
V_{EF}	4.96
V_{AF}	10.01
V_{BF}	2.73
V_{DF}	2.38

Conclusions:

The objectives of this lab were performed successfully. Students became adept in constructing parallel and in series circuits and were able to differentiate between the two. In order to calculate the equivalent resistance of the whole circuit or at different resistors, students learned to combine resistors using the **Node Voltage Method** or the **Mesh Current Method.** These methods also helped find the voltages and currents going through each resistor. Either method can be used since they will both produce the same value.