Lab Session 05
Analyze and Implement Nodal Analysis

Objective

The study of nodal analysis is the objective of this exercise, specifically its usage in multi-source DC circuits. Its application to finding circuit currents and voltages will be investigated.

Theory Overview

Multi-source DC circuits may be analyzed using a node voltage technique. The process involves identifying all of the circuit nodes, a node being a point where various branch currents combine. A reference node, usually ground, is included. Kirchhoff's Current Law is then applied to each node. Consequently a set of simultaneous equations are created with an unknown voltage for each node with the exception of the reference. In other words, a circuit with a total of five nodes including the reference will yield four unknown node voltages and four equations. Once the node voltages are determined, various branch currents and component voltages may be derived.

Equipment

(1) Adjustable DC Power Supply
(2) Digital Multimeter
(3) 4.7 kΩ
(4) 6.8 kΩ
(5) 10 kΩ
(6) 22 kΩ
(7) 33 kΩ

Schematics

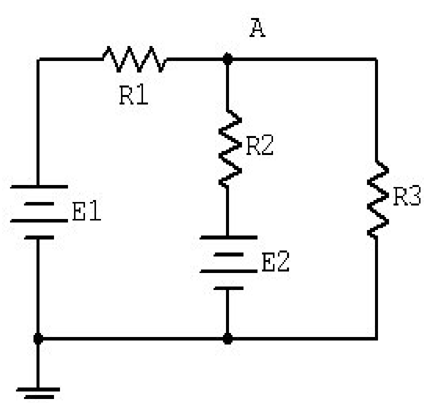

Figure 5.1

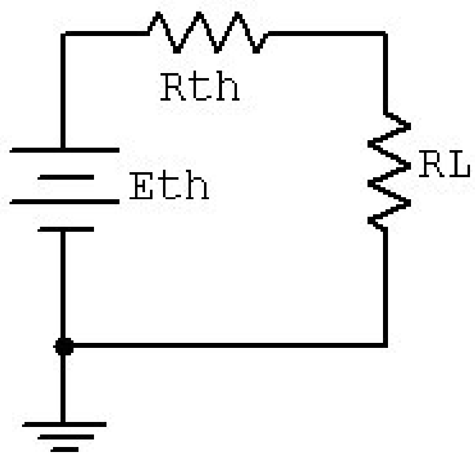

Figure 5.2

Procedure

1. Consider the dual supply circuit of Figure 5.1 using E1 = 10 volts, E2 = 15 volts, R1 = 4.7 k, R2 = 6.8 k and R3 = 10 k. To find the voltage from node A to ground, nodal analysis may be applied. In this circuit note that there is only one node and therefore only one equation with one unknown is needed. Once this potential is found, all other circuit currents and voltages may be found by applying Ohm's Law and/or KVL and KCL.

2. Write the node equation for the circuit of Figure 5.1 and solve for node voltage A. Also, determine the current through R3. Record these values in Table 5.1.

3. Construct the circuit of Figure 5.1 using the values specified in step one. Measure the voltage from node A to ground along with the current though R3. Record these values in Table 5.1. Also determine and record the deviations.

4. Consider the dual supply circuit of Figure 5.2 using E1 = 10 volts, E2 = 15 volts, R1 = 4.7 k, R2 = 6.8 k, R3 = 10 k, R4 = 22 k and R5 = 33 k. Applying nodal analysis to this circuit yields two equations with two unknowns, namely node voltages A and B. Again, once these potentials are found, any other circuit current or voltage may be determined by applying Ohm's Law and/or KVL and KCL.
5. Write the node equations for the circuit of Figure 5.2 and solve for node voltage A, node voltage B and the potential from A to B. Also, determine the current through R4. Record these values in Table 5.2.

6. Construct the circuit of Figure 5.2 using the values specified in step four. Measure the voltages from node A to ground, node B to ground and from node A to B, along with the current though R4. Record these values in Table 5.2. Also determine and record the deviations.

Simulation

7. Build the circuit of Figure 5.2 in a simulator. Using the DC Operating Point simulation function, determine the voltages at nodes A and B, and compare these to the theoretical and measured values recorded in Table 5.2.

Data Tables

Parameter	Theory	Experimental	Deviation
V_A			
I_{R3}			

Table 5.1

Parameter	Theory	Experimental	Deviation
V_A			
V_B			
V_{AB}			
I_{R4}			

Table 5.2

Conclusions & Comments:

Questions

1. Do the polarities of the sources in Figure 5.1 matter as to the resulting voltages? Will the magnitudes of the voltages be the same if one or both sources have an inverted polarity?

2. In both circuits of this exercise the negative terminals of the sources are connected to ground. Is this a requirement for nodal analysis? What would happen to the node voltages if the positions of E1 and R1 in Figure 5.1 were swapped?

3. The circuits of Figures 5.1 and 5.2 had been analyzed previously in the Superposition Theorem exercise. How do the results of this exercise compare to the earlier results? Should the resulting currents and voltages be identical? If not, what sort of things might affect the outcome?