Lab Session 06
Analyze and Implement Mesh Analysis

Objective
The study of mesh 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 mesh current technique. The process involves identifying a minimum number of small loops such that every component exists in at least one loop. Kirchhoff's Voltage Law is then applied to each loop. The loop currents are referred to as mesh currents as each current interlocks or meshes with the surrounding loop currents. As a result there will be a set of simultaneous equations created, an unknown mesh current for each loop. Once the mesh currents 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

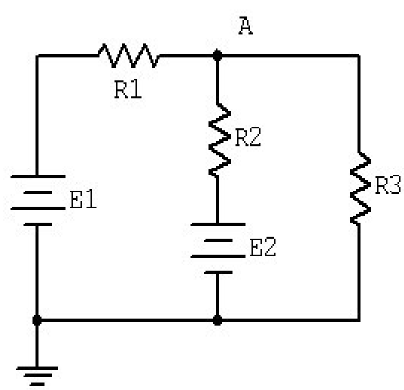

Figure 6.1

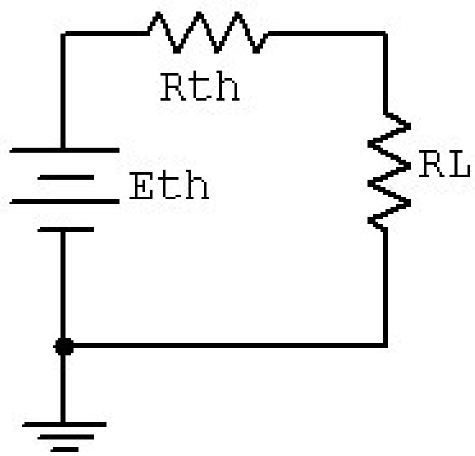

Figure 6.2

Procedure

1. Consider the dual supply circuit of Figure 6.1 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, mesh analysis may be used. This circuit may be described via two mesh currents, loop one formed with E1, R1, R2 and E2, and loop two formed with E2, R2 and R3. Note that these mesh currents are the currents flowing through R1 and R3 respectively.

2. Using KVL, write the loop expressions for these two loops and then solve to find the mesh currents. Note that the third branch current (that of R2) is the combination of the mesh currents and that the voltage at node A can be determined using the second mesh current and Ohm's Law. Compute these values and record them in Table 6.1.

3. Build the circuit of Figure 6.1 using the values specified in step one. Measure the three branch currents and the voltage at node A and record in Table 6.1. Be sure to note the directions and polarities. Finally, determine and record the deviations in Table 6.1.

4. Consider the dual supply circuit of Figure 6.2 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. This circuit will require three loops to describe fully. This means that there will be three mesh currents in spite of the fact that there are five branch currents. The three mesh currents correspond to the currents through R1, R2, and R4.

5. Using KVL, write the loop expressions for these loops and then solve to find the mesh currents. Note that the voltages at nodes A and B can be determined using the mesh currents and Ohm's Law. Compute these values and record them in Table 6.2.
6. Build the circuit of Figure 6.2 using the values specified in step four. Measure the three mesh currents and the voltages at node A, node B, and from node A to B, and record in Table 6.2. Be sure to note the directions and polarities. Finally, determine and record the deviations in Table 6.2.

Data Tables

Parameter	Theory	Experimental	Deviation
I_{R1}			
I_{R2}			
I_{R3}			
V_A			

Table 6.1

Parameter	Theory	Experimental	Deviation
I_{R1}			
I_{R2}			
I_{R4}			
V_A			
V_B			
V_{AB}			

Table 6.2

Conclusions & Comments:

Questions

1. Do the polarities of the sources in Figure 6.1 matter as to the resulting currents? Will the magnitudes of the currents 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 mesh analysis? What would happen to the mesh currents if the positions of E1 and R1 in Figure 6.1 were swapped?

3. The circuits of Figures 6.1 and 6.2 had been analyzed previously in the Superposition Theorem and Nodal Analysis exercises. 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?