EXPERIMENT 3 : SERIES-PARALLEL CIRCUIT

OBJECTIVE

Understanding mixed circuit logic.

EQUIPMENT NEEDED:

- DC Power Supply
- DMM
- Resistors

THEORY

Three basic laws can be used to solve a vast majority of circuits, Kirchoff's voltage law (KVL), Kirchoff's current law (KCL) and Ohm's law. KVL states that the sum of all the voltage drops in a circuit must equal zero. KCL states that the current entering a node must be equal to the current leaving the node. Ohms law shows the correlation between voltage, current, and resistance and is expressed as $V = IR$.

PRELIMINARY CALCULATIONS:

1. For the circuit of Figure 3.1 calculate the resistance between nodes:
    a. A and B
    b. A and C
    c. C and D

    Hint: Part c cannot immediately be reduced using series and parallel combinations.

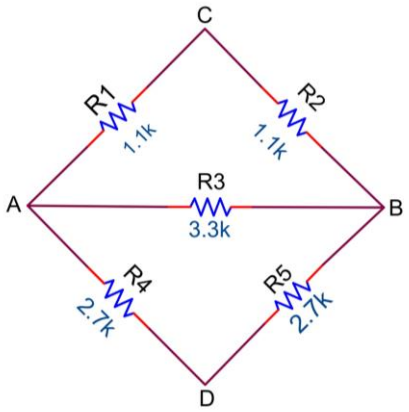


Figure 3.1

	R_{A-B}	R_{A-C}	R_{C-D}
Calculated	~1012Ω	~753Ω	~2688Ω

2. Calculate V_3 and V_4 for the circuit in Figure 3.2.

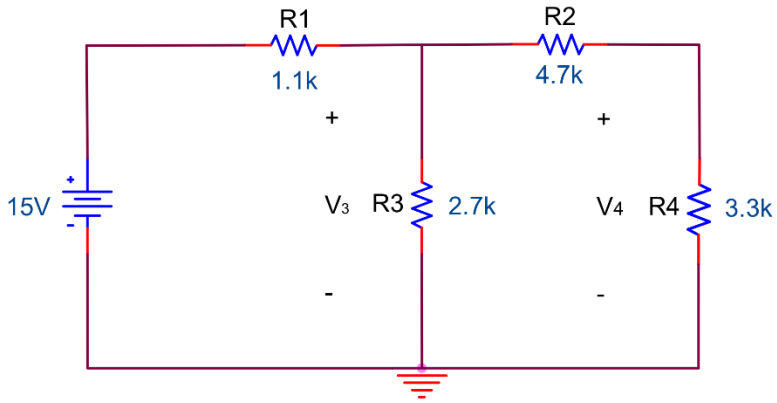


Figure 3.2

	V_3	V_4
Calculated		

3. Calculate all voltages and currents in Figure 3.3 and Figure 3.4.

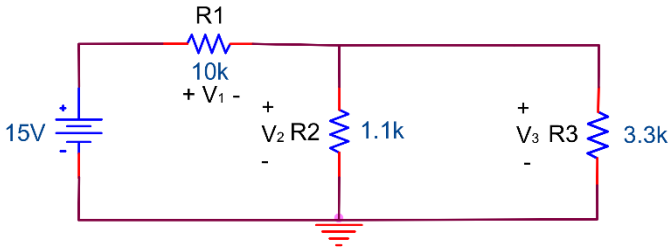


Figure 3.3

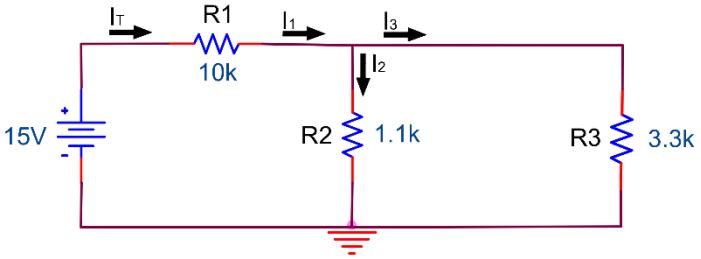


Figure 3.4

	V_1	V_2	V_3	I_1	I_2	I_3	I_T
Calculated							

4. Calculate all voltages and currents in Figure 3.5 and Figure 3.6.

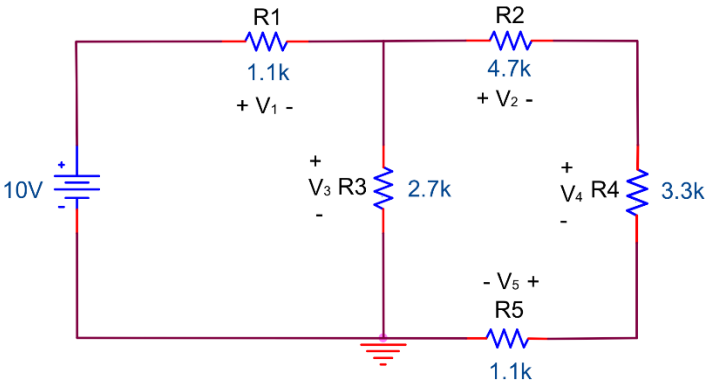


Figure 3.5

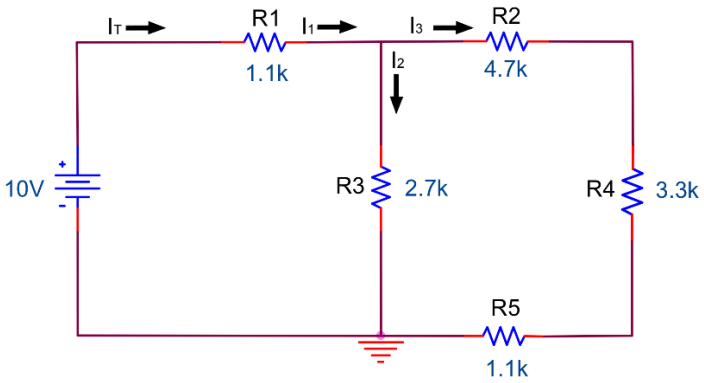


Figure 3.6

	V_1	V_2	V_3	V_4	V_5	I_1	I_2	I_3
Calculated								

PROCEDURE

1. Measure and record R_{ab} (Figure 3.7), R_{ac}(Figure 3.8), and R_{cd} (Figure 3.9).

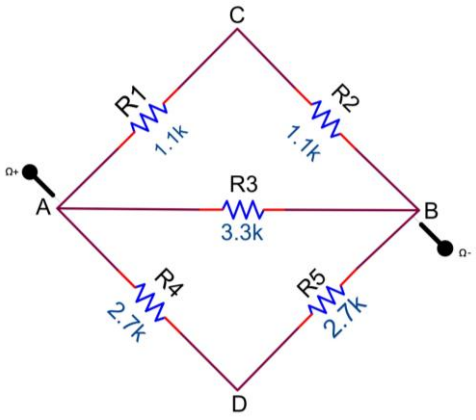


Figure 3.7

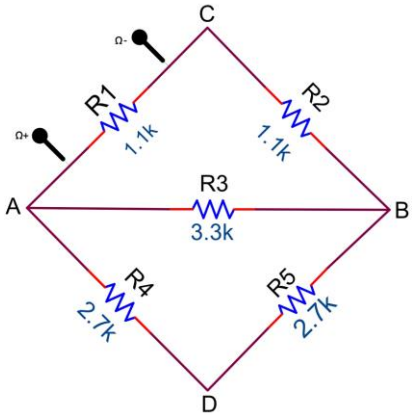


Figure 3.8

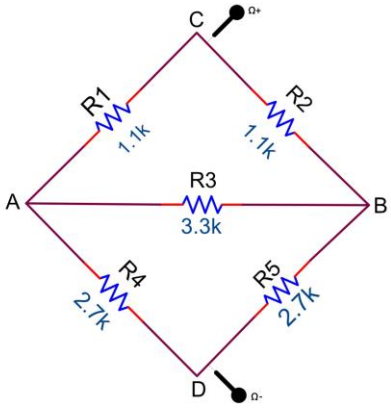


Figure 3.9

Resistance	Calculated	Measured	Percent Error
R_{ab}	1.012kΩ	1.023kΩ	1.09%
R_{ac}	753Ω	742Ω	-1.33%
R_{cd}	1.85kΩ	1.8385kΩ	-0.62%

2. Construct the circuit in Figure 3.10. Measure V_3 and V_4 using the DMM. Calculate the percent error.

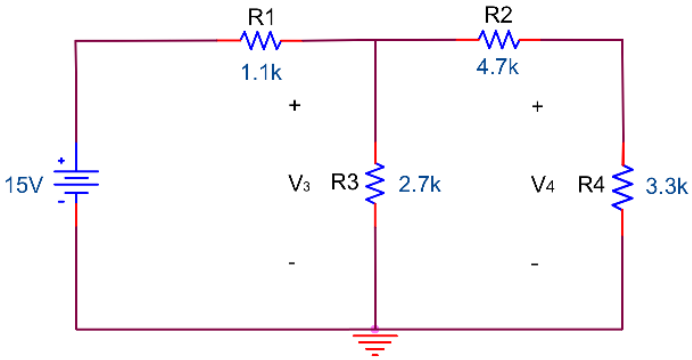


Figure 3.10

	V_3	V_4
Calculated	10.031	4.14
Measured	10.087	4.165
Percent Error	0.56%	0.60%

3. Measure and record the voltages and currents depicted in Figure 3.11 and Figure 3.12.

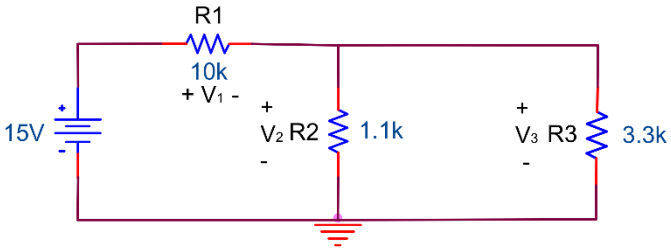


Figure 3.11

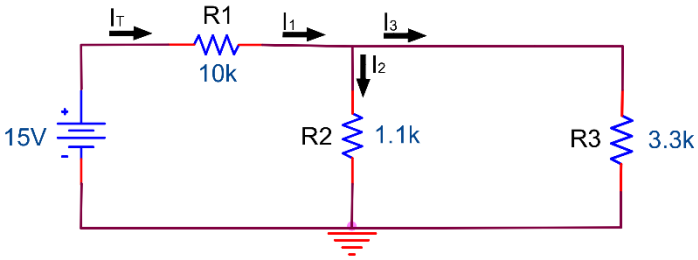


Figure 3.12

	R_1	R_2	R_3	V_1	V_2	V_3	I_1	I_2	I_3	I_T
Calculated	10kΩ	1.2kΩ	3.3kΩ	13.931	1.069	1.069	1.393m	1.069m	0.324m	1.393m
Measured	9.86kΩ	1.198kΩ	3.29kΩ	13.93	1.0693	1.0693	1.415m	1.090m	0.326m	1.415m
Percent Error	-1.4%	-0.17%	-0.30%	-0.01%	0.028%	0.028%	1.57%	1.96%	0.62%	0.02%

4. Construct Figure 3.13. Using the DMM, measure each of the variables and calculate the percent error for each.

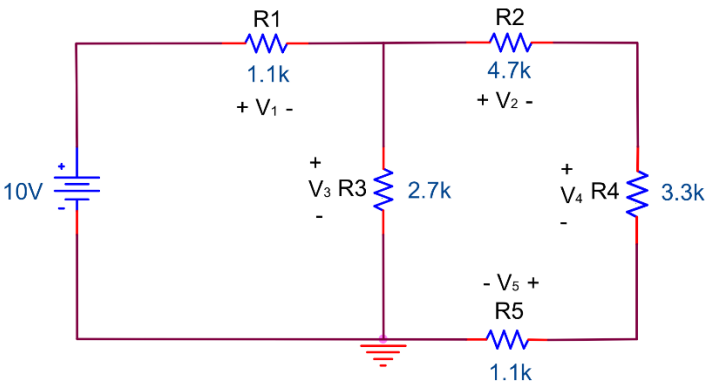


Figure 3.13

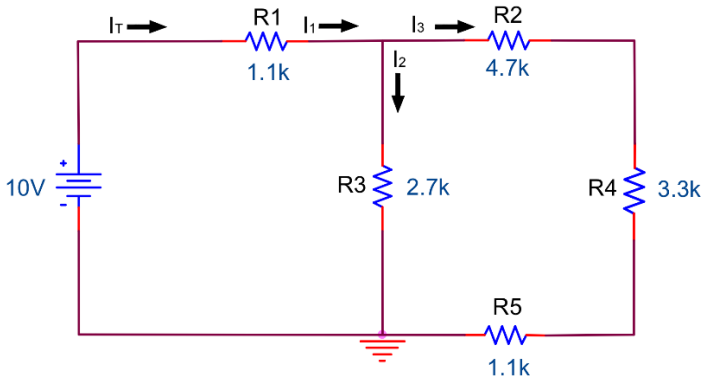


Figure 3.14

	V_1	V_2	V_3	V_4	V_5	I_1	I_2	I_3	I_4	I_5
Calculated	3.25	3.525	6.75	2.475	0.75	2.5m	0.75m	3.25m	N/A	N/A
Measured	3.17	3.52	6.78	2.45	0.67	2.46	0.74	3.23	N/A	N/A
Percent Error	-1.46%	-0.14%	0.44%	1.46%	-1.01%	1.46%	1.6%	-0.615%	N/A	N/A

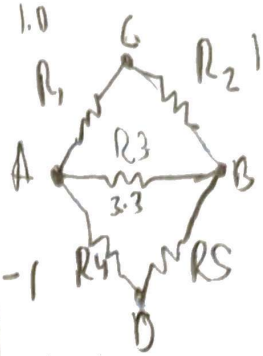
$R_1 = 1k \quad R_2 = 1k$

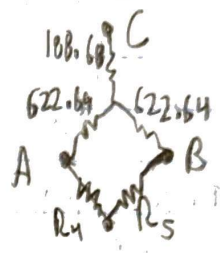
$R_3 = 3.3k \quad R_4 = 2.7k, \quad R_5 = 2.7k$

1.

$$R_{a-b} = \left(\frac{1}{R_1 + R_2} + \frac{1}{R_3} + \frac{1}{R_4 + R_5} \right)^{-1}$$

$$R_{a-c} = \left(\frac{1}{\left(\frac{1}{R_4 + R_5} + \frac{1}{R_3} \right)^{-1} + R_2} + \frac{1}{R_1} \right)^{-1}$$





$$R_{A,B,C} = \frac{R_1 R_3}{R_1 + R_2 + R_3} = \frac{(1.1k)(3.3k)}{(1.1k + 3.3k + 1.1k)}$$

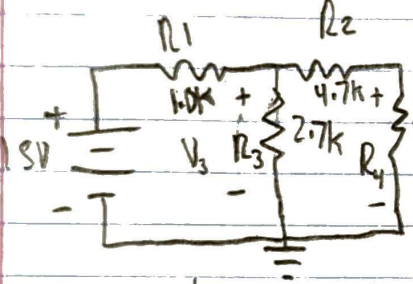
$R_{eq} = 1900\Omega$

(C) $R_{c-d} = 1850\Omega$

$R_{a-b} = 1012\Omega$ (A)

$R_{a-c} = 753\Omega$ (B)

2.



$R_{eq} \approx 3018.69$

$I_{tot} \approx 4.969mA$

$I_3 = 4.969 \left(\frac{4.7k + 3.3k}{(2.7 + 4.7 + 3.3k)} \right)$

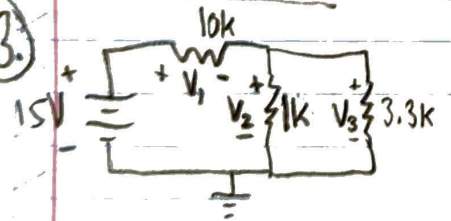
$\approx 3.715mA \cdot 3.3k \approx 12.26V$

$I_4 = 4.969 \left(\frac{2.7}{(2.7 + 4.7 + 3.3k)} \right)$

$\approx 1.254mA \cdot 3300 \approx 4.138V$

	V_3	V_4
calculated	10.031	4.14V

3.



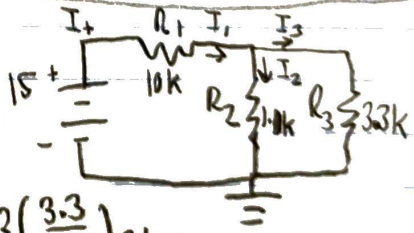
$R_{eq} = 10.825k\Omega$

$\frac{15}{10.767} \approx 1.393mA = I_1$

$V_1 = 1.393(10) \approx 13.931V$

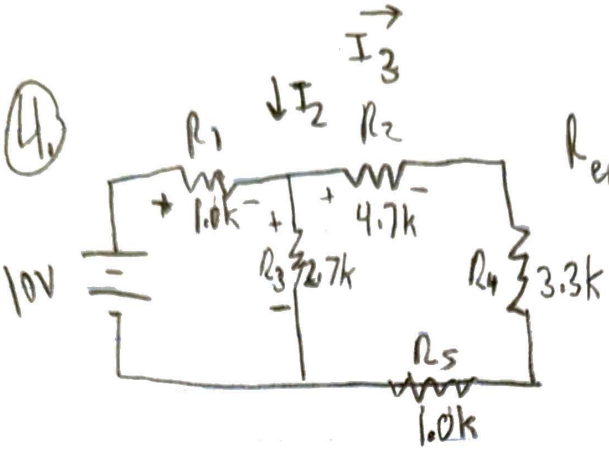
$V_2 = 1.069V \quad I_2 = 1.393 \left(\frac{3.3}{1 + 3.3} \right) \approx 1.069$

$V_3 = 1.069V \quad I_3 = 1.393 \left(\frac{1}{4.3} \right) \approx 0.324$



	V_1	V_2	V_3	I_1	I_2	I_3
Calculated	13.931V	1.069V	1.069V	1.393mA	1.069mA	0.324mA

4.



$R_{eq} = \frac{40}{13} \approx 3.077$

$I_T = I_1 = \frac{13}{4} \approx 3.25\text{mA}$

$V_1 = 3.25 \cdot 1 \approx 3.25\text{V}$

$I_2 = 3.25\left(\frac{9}{9+2.7}\right) \approx 2.5\text{mA}$ $V_2 \approx 3.525\text{V}$

$I_3 = 3.23\left(\frac{2.7}{9+2.7}\right) \approx 0.75\text{mA}$ $V_3 \approx 2.5 \cdot 2.7 \approx 6.75\text{V}$

$I_1 \approx 3.25\text{mA}$

$\cdot 3.3$ $V_4 \approx 2.475\text{V}$

$V_5 \approx .75 \cdot 1.0 = 0.75$

	V_1	V_2	V_3	V_4	V_5	I_1	I_2	I_3
Calculated	3.25	3.525	6.75	2.475	0.75	2.5mA	0.75mA	3.25mA

3.3k

2.7k