Introduction:

This experiment is to show students the application of Superposition Theorem to make circuit analysis easy. **Superposition theorem** states that if there are more than one source in an electric network, the voltage or current response can be determined by considering one source at a time and finally the total response is the algebraic sum of the individual responses. Given that when determining the response with a particular source, all the other sources have to be deactivated by replacing voltage sources with short circuits and current sources with open circuits. It also tries to explain on what quantities (current, voltage or power) it applies on, the type of circuits the superposition theorem applies and even tries to correlate theoretically given lectures on Superposition Theorem

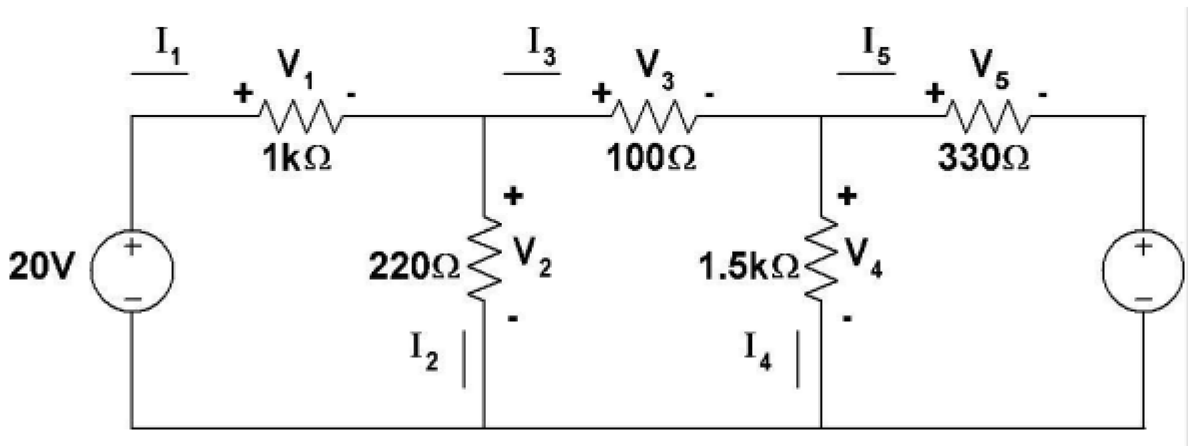

Figure 1: Resistive Circuit with two Sources

Procedures

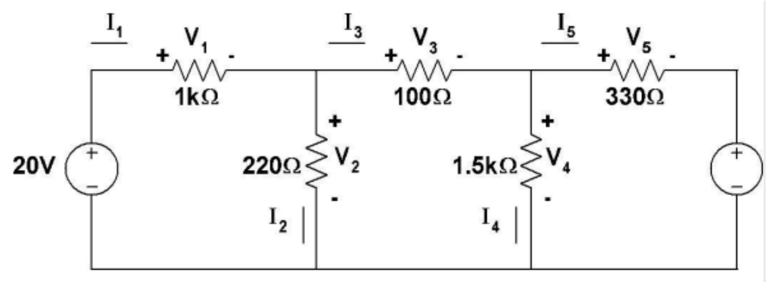

Figure 1: Resistive Circuit with two Sources

i. The diagram above, which is figure 1, was constructed on Multisim. Then a series of multimeters were connected in series to each resistor to measure the current through it and the resulting values were recorded as shown below in figure 2.1 and figure 2.2.

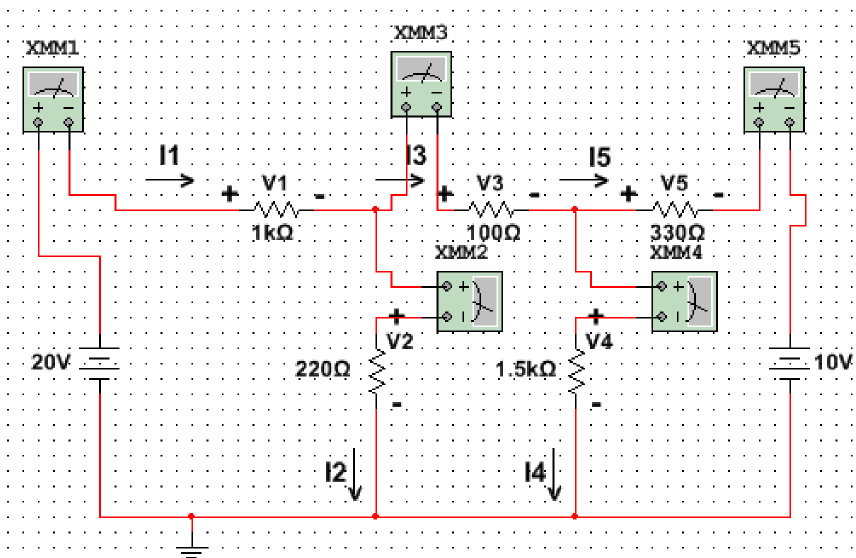

Figure 2.1: Construction of circuit with multimeters to measure current

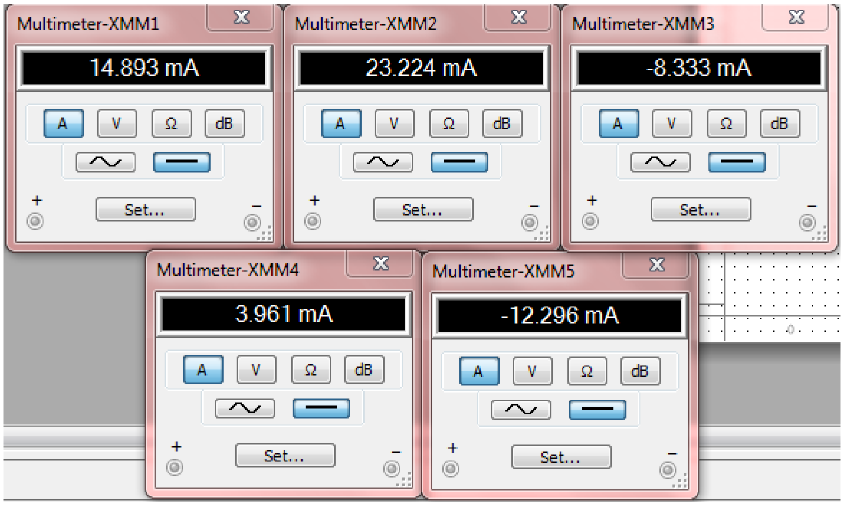

Figure 2.2: Simulation Results for Current through each resistors

ii. After measuring the current through each resistors the multimeters were disconnected and again connected in parallel to each resistor to measure the voltage across each resistor and the resulting values were recorded as shown below in figure 3.1 and 3.2.

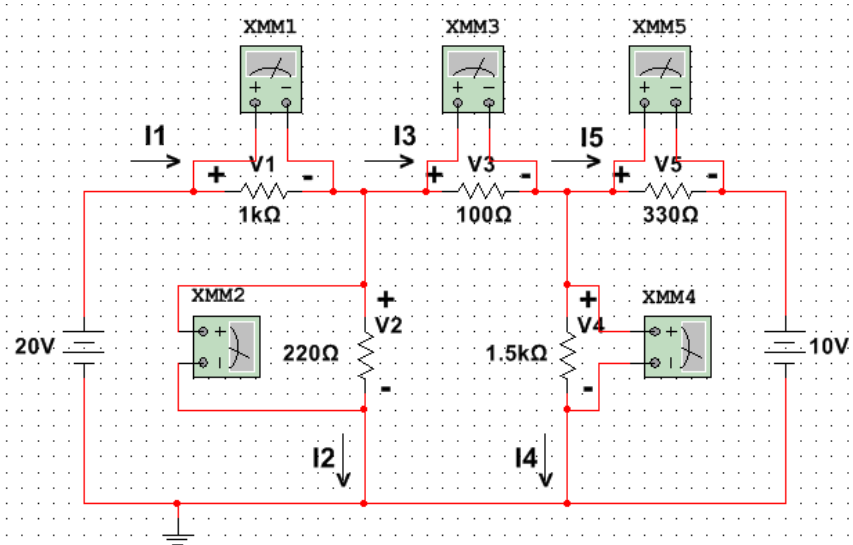

Figure 3.1: Connecting Multimeters in Parallel to Measure Voltage

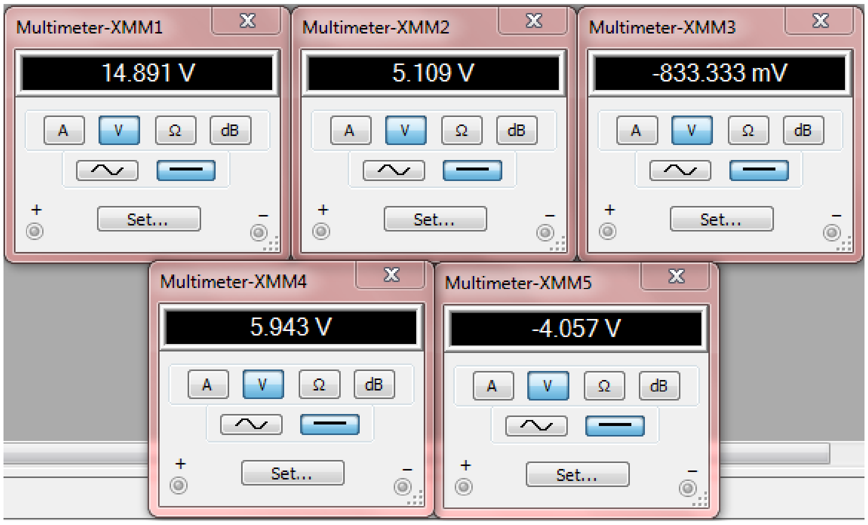

Figure 3.2: Simulation Results for Voltage across each resistors

iii. After measuring the current and voltage through and across each resistor in the circuit, the 10-V voltage source was removed from the circuit and replaced by a short circuit and the currents and voltages through and across each resistor was measured and recorded as shown below in figure 4.1, 4.2, 4.3 and 4.4.

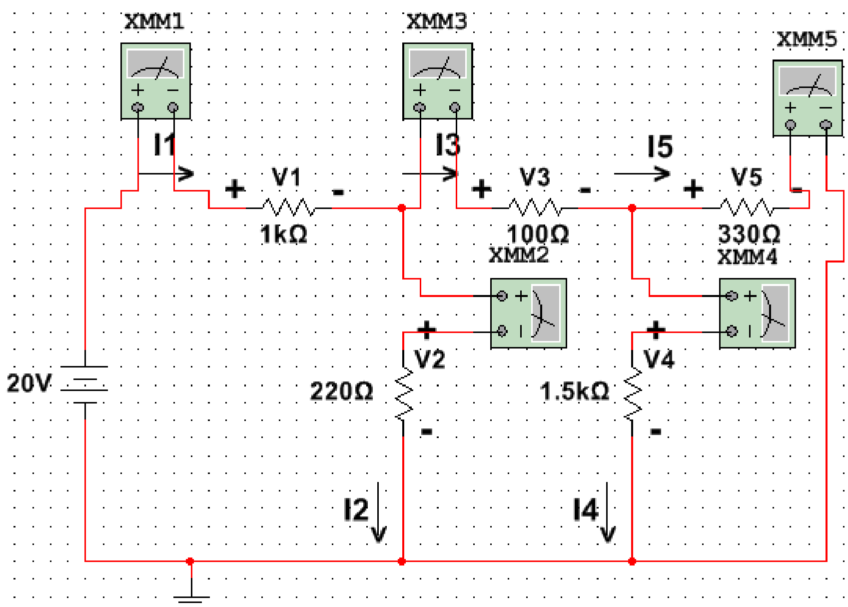

Figure 4.1: Connecting Multimeters in Series to Measure Current (10-V removed)

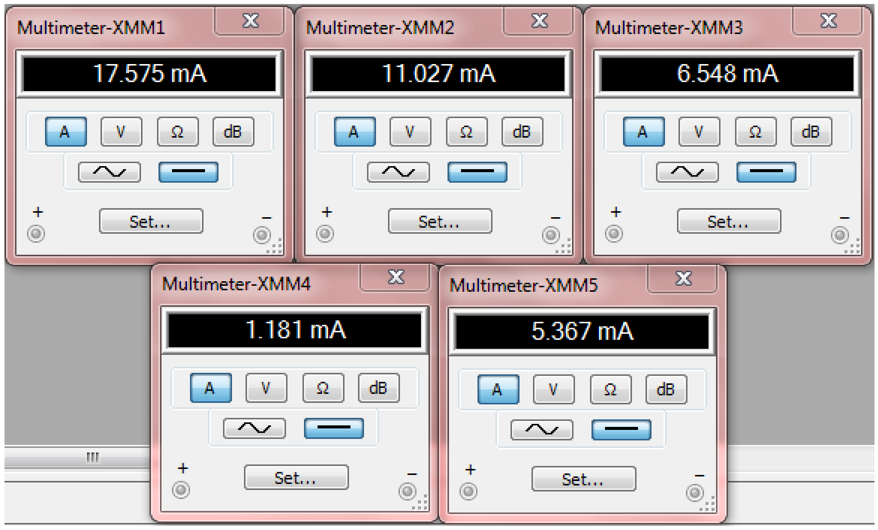

Figure 4.2: Simulation Results for Current through each resistors (10-V removed)

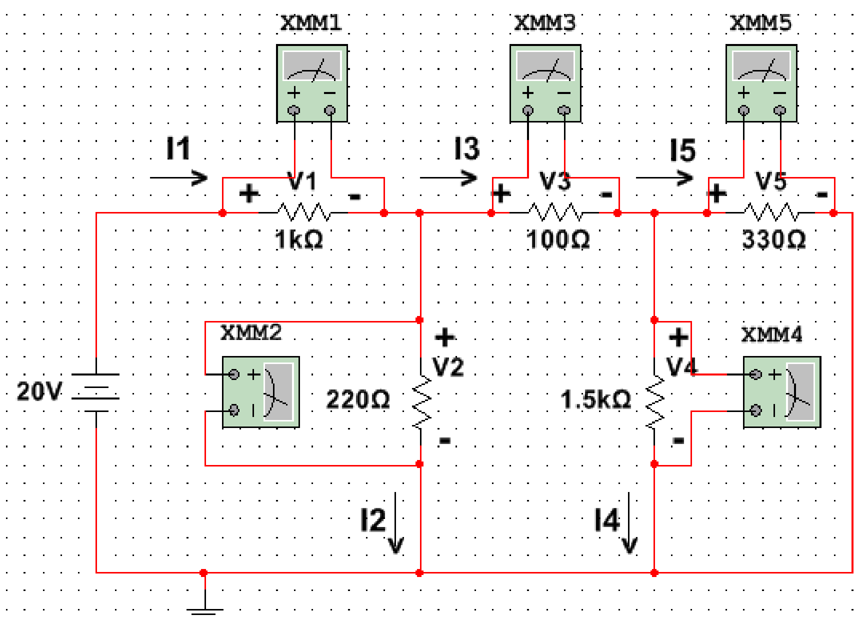

Figure 4.3: Connecting Multimeters in Parallel to Measure Voltage (10-V removed)

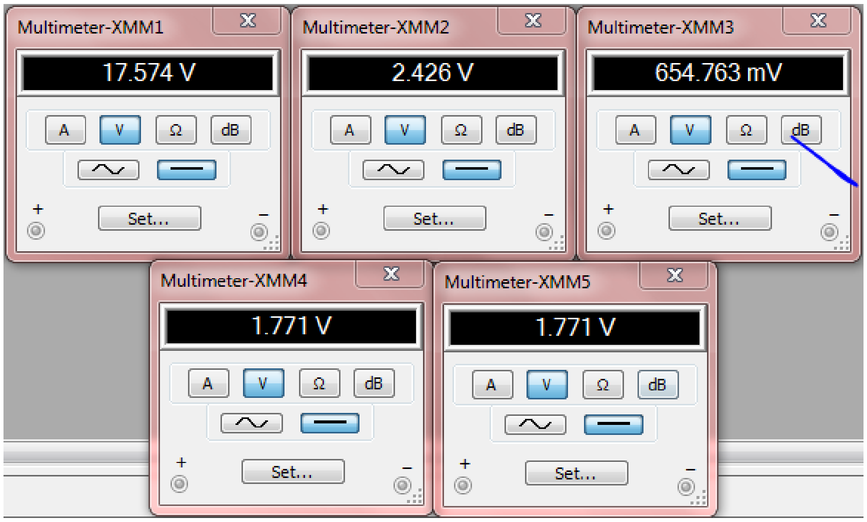

Figure 4.4: Simulation Results for Voltage across each resistors (10-V removed)

iv. After measuring the circuit values (current and voltage) by removing the 10-V voltage source, the source was putted back again and the 20-V voltage source was removed and replaced by a short circuit and the currents and voltages through and across each resistor was measured and recorded as shown below in figure 5.1, 5.2, 5.3 and 5.4.

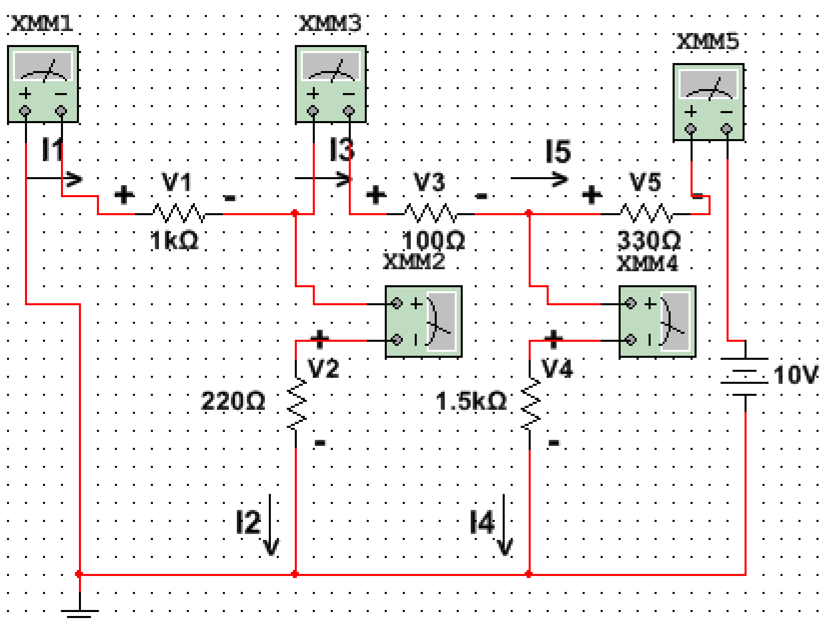

Figure 5.1: Connecting Multimeters in Series to Measure Current (20-V removed)

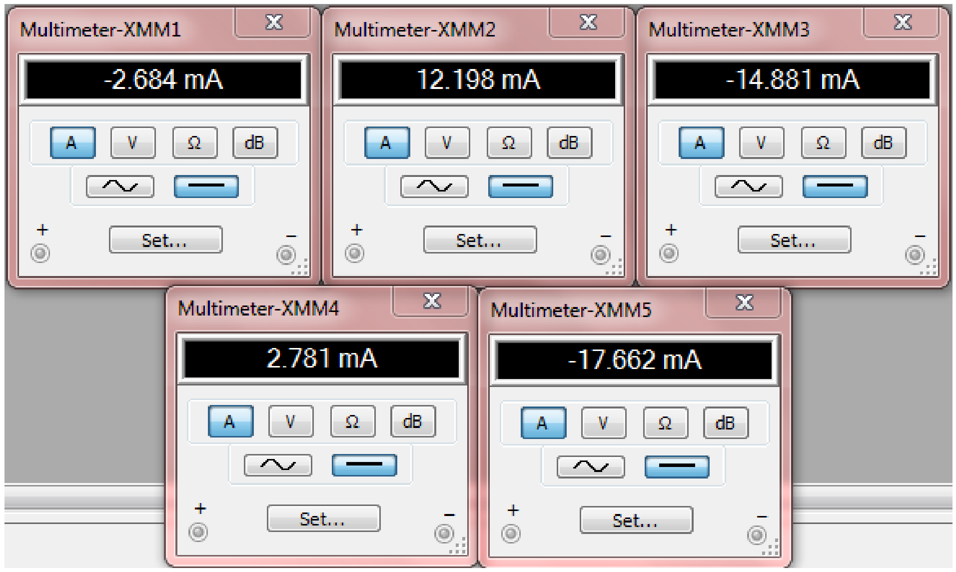

Figure 5.2: Simulation Results for Current through each resistors (20-V removed)

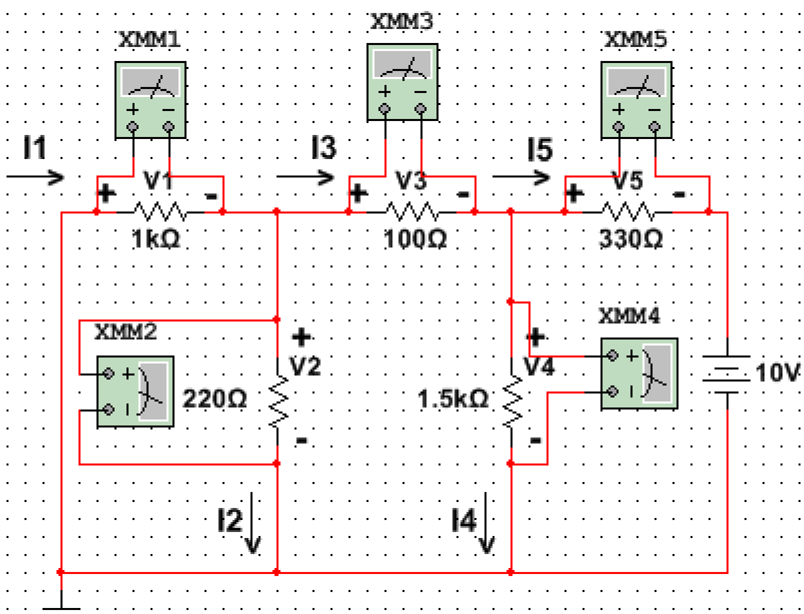

Figure 5.3: Connecting Multimeters in Parallel to Measure Voltage (20-V removed)

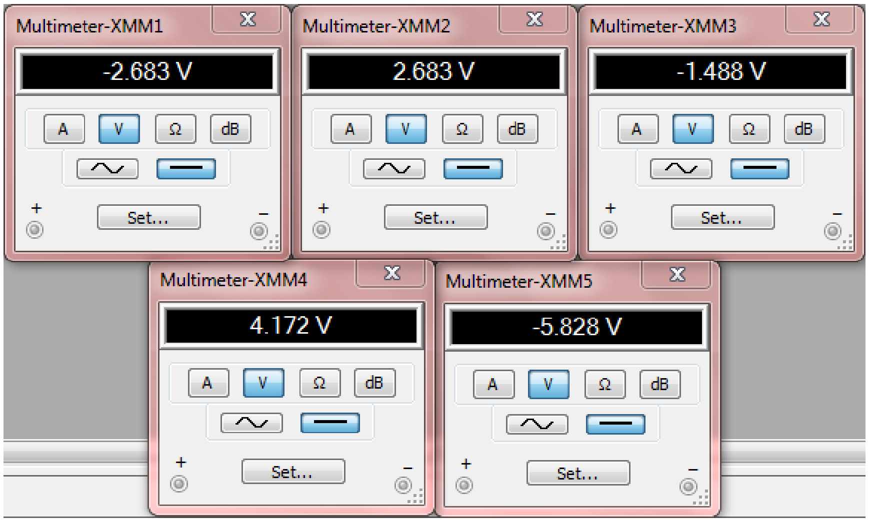

Figure 5.4: Simulation Results for Voltage across each resistors (20-V removed)

Analysis and Answers

Table 1: Simulation results for voltage and current with both sources

Resistors	**1 KΩ**	**220 Ω**	**100 Ω**	**1.5 KΩ**	**330 Ω**
Voltage (V)	14.891	5.109	-833.33 m	5.943	-4.057
Current (mA)	14.893	23.225	-8.333	3.962	-12.294

Table 2: Simulation results for voltage and current with the 20-V source only

Resistors	**1 KΩ**	**220 Ω**	**100 Ω**	**1.5 KΩ**	**330 Ω**
Voltage (V)	17.574	2.426	654.763 m	1.771	1.771
Current (mA)	17.575	11.027	6.548	1.181	5.367

Table 3: Simulation results for voltage and current with the 10-V source only

Resistors	**1 KΩ**	**220 Ω**	**100 Ω**	**1.5 KΩ**	**330 Ω**
Voltage (V)	-2.683	2.683	-1.488	4.172	-5.828
Current (mA)	-2.684	12.198	-14.881	2.781	-17.661

Table 4: Comparison results for voltage and current with Superposition Theorem and General Analysis

Resistors		1 KΩ	220 Ω	100 Ω	1.5 KΩ	330 Ω
Voltage (V)	**Superposition**	14.891	5.109	-833.33 m	5.943	-4.057
	General	14.891	5.109	-833.33 m	5.943	-4.057
Current (mA)	**Superposition**	14.893	23.225	-8.333	3.962	-12.294
	General	14.893	23.225	-8.333	3.962	-12.294

The answer for the Questions are as follow

Q1. The Superposition principle is verified and accurate. The circuit values analyzed using the Superposition Theorem and the circuit as a whole was the same.

Q2. Superposition Theorem applies for certain types of circuits only. This circuits are those having a linear relationship of input and output, implying that the output is linearly related to its input.

Q3. Superposition Theorem abides with the linear property. Superposition does not apply for power because $p = i^2 R$ or $p = v^2/ R$ (making it a quadratic function rather than a linear one), the relationship between power and voltage (or current) is nonlinear. As a result the power cannot be found directly by applying the superposition theorem.

Conclusion

By accomplishing the experiment we have given to day we gained the ability on how to verify and apply superposition theorem using NI Multisim and also how to know when to apply the theorem according to the circuit input-output relation and on what circuit parameters it applies on (current, voltage and power).

Appendix

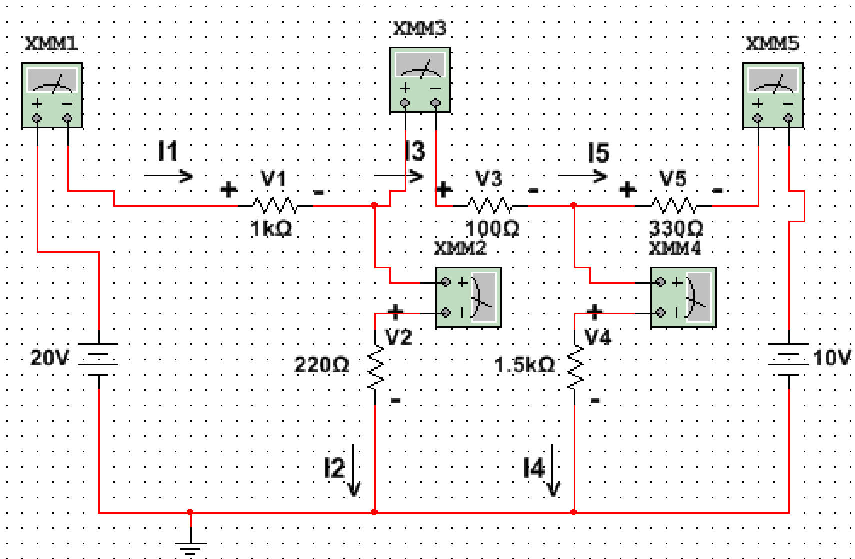

Figure 2.1: Construction of circuit with multimeters to measure current

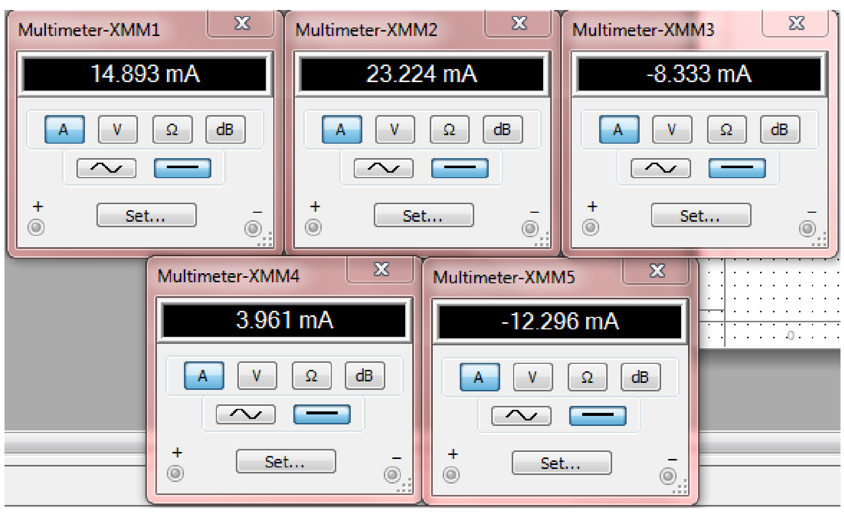

Figure 2.2: Simulation Results for Current through each resistors

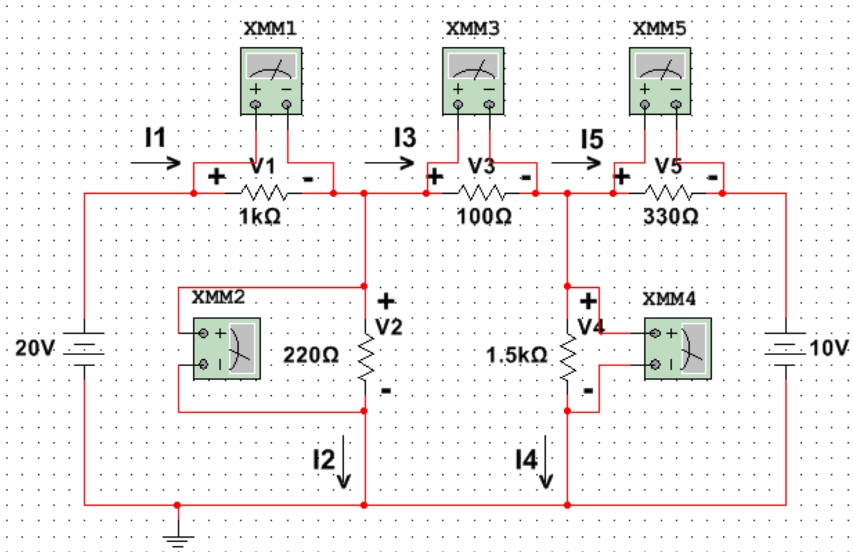

Figure 3.1: Connecting Multimeters in Parallel to Measure Voltage

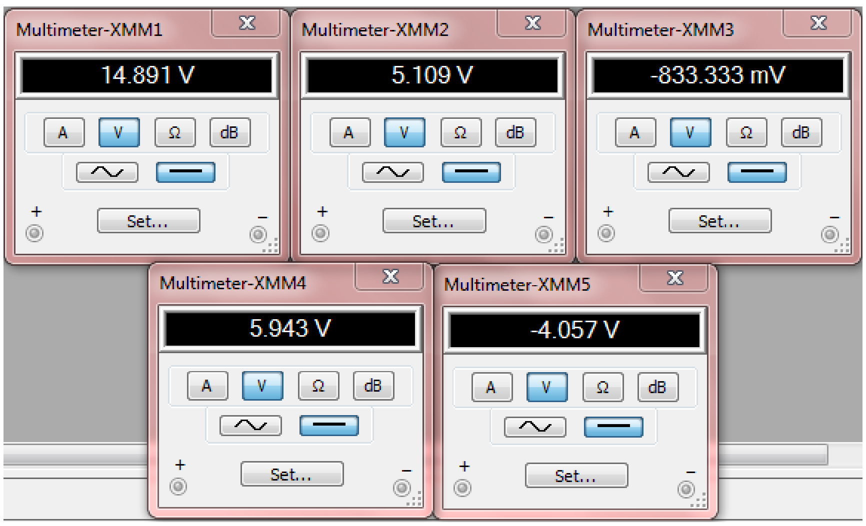

Figure 3.2: Simulation Results for Voltage across each resistors

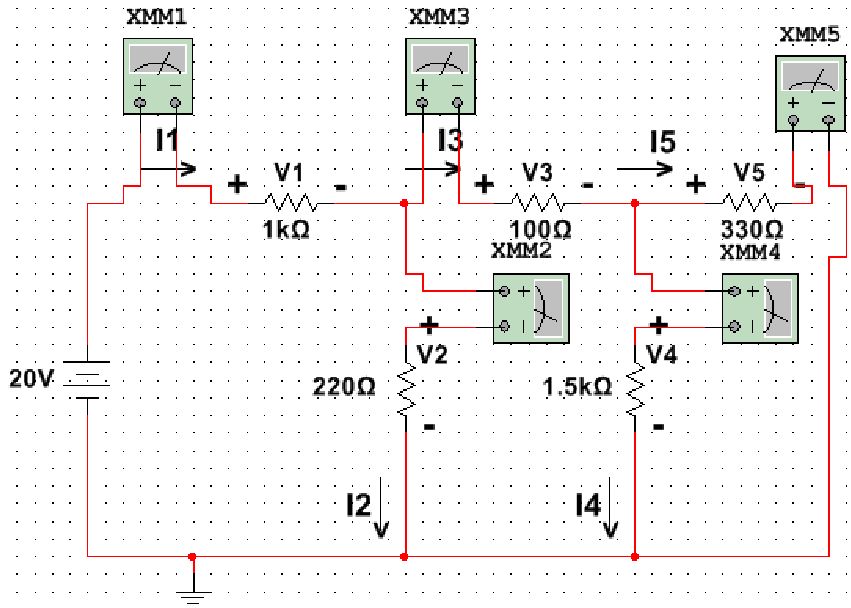

Figure 4.1: Connecting Multimeters in Series to Measure Current (10-V removed)

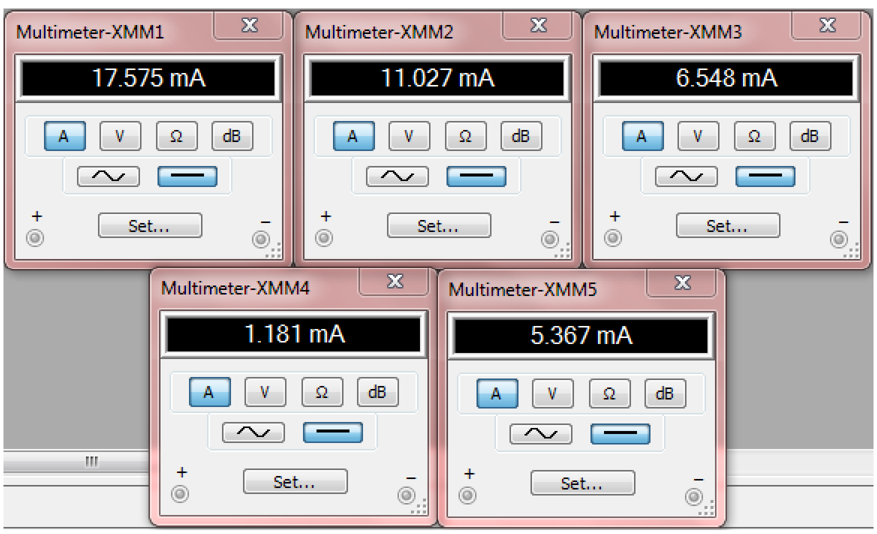

Figure 4.2: Simulation Results for Current through each resistors (10-V removed)

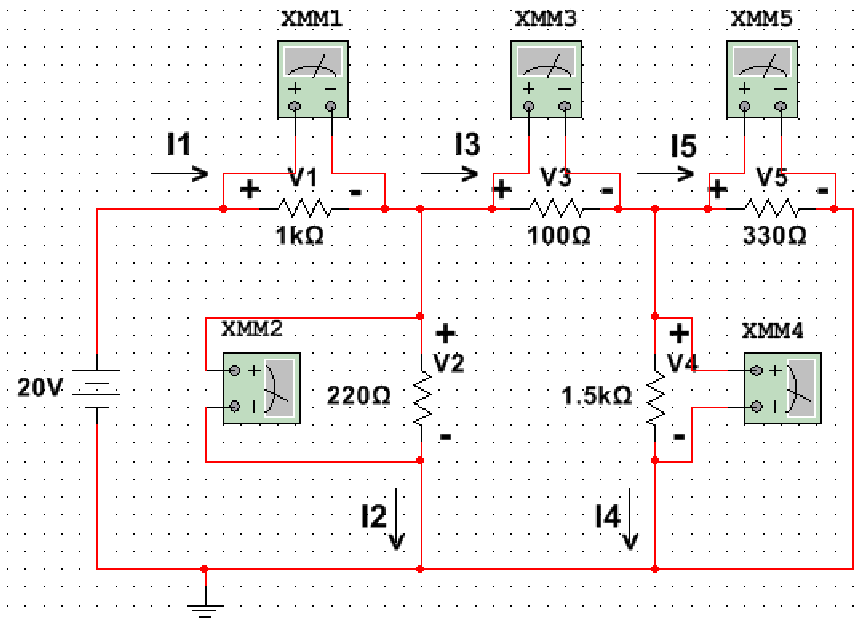

Figure 4.3: Connecting Multimeters in Parallel to Measure Voltage (10-V removed)

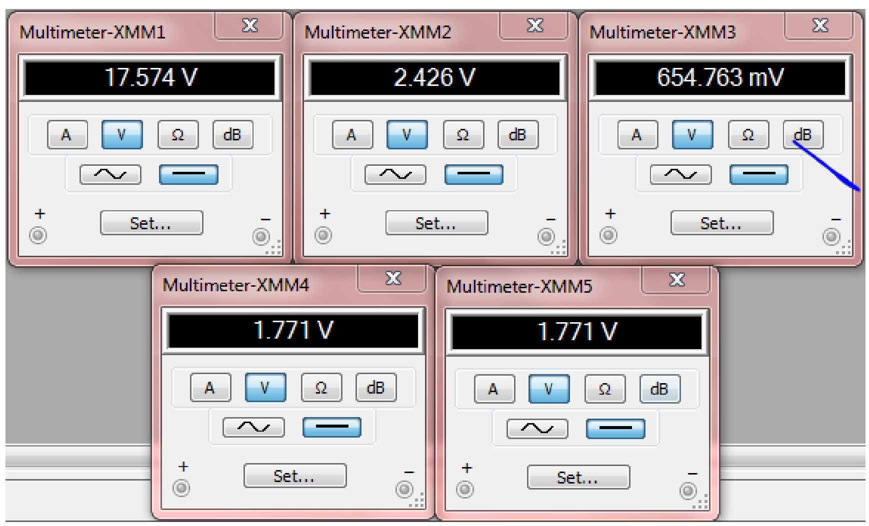

Figure 4.4: Simulation Results for Voltage across each resistors (10-V removed)

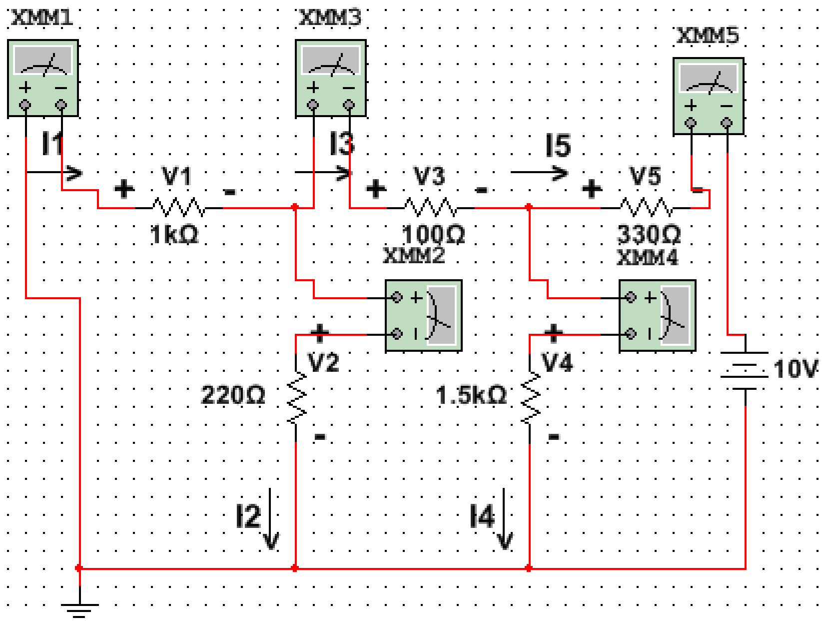

Figure 5.1: Connecting Multimeters in Series to Measure Current (20-V removed)

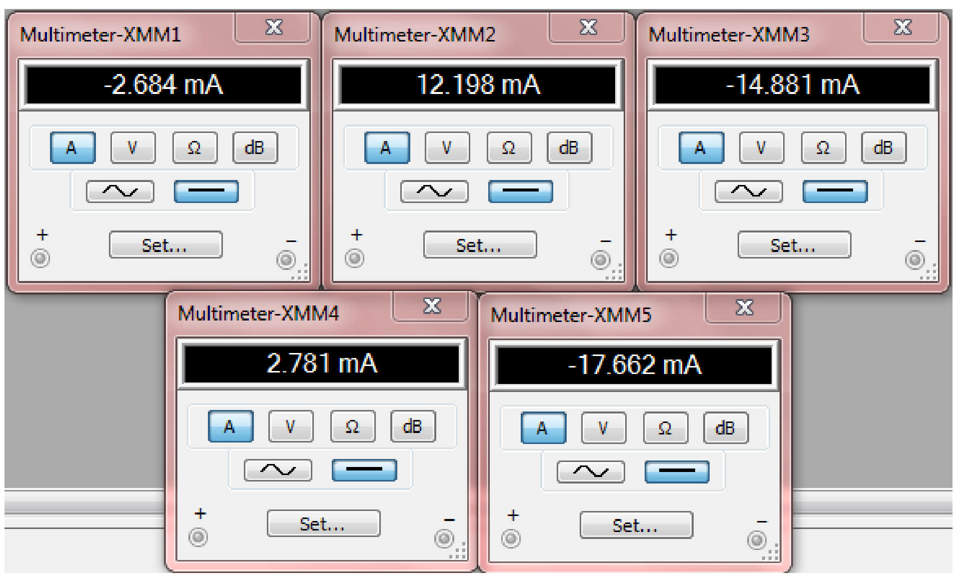

Figure 5.2: Simulation Results for Current through each resistors (20-V removed)

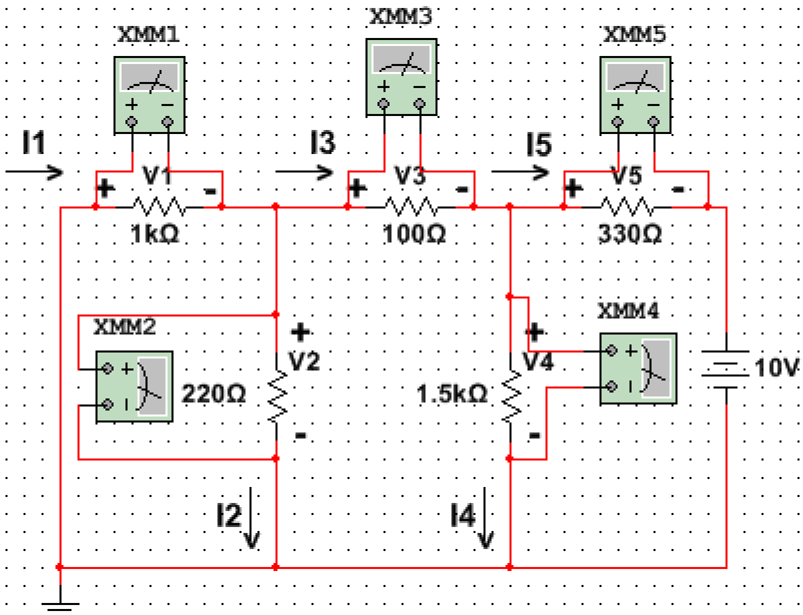

Figure 5.3: Connecting Multimeters in Parallel to Measure Voltage (20-V removed)

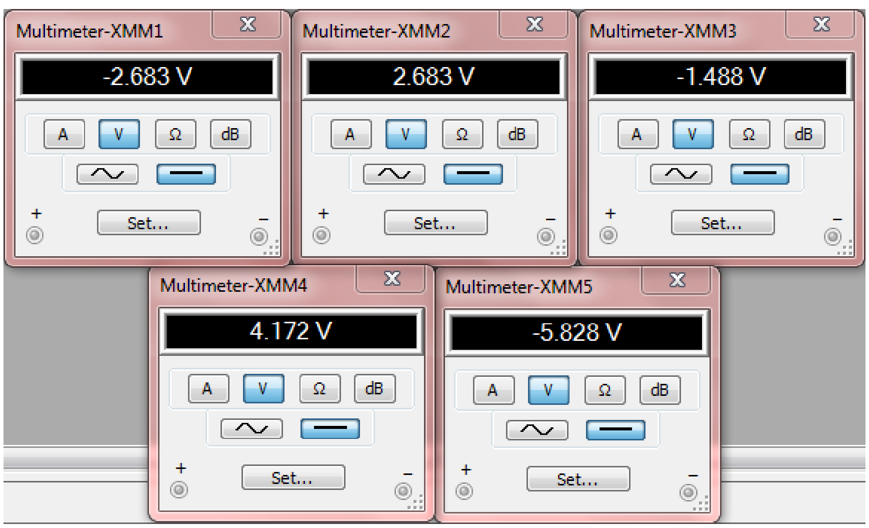

Figure 5.4: Simulation Results for Voltage across each resistors (20-V removed)