Feng Chia University

Electrical Engineering Fundamentals I Lab

Laboratory 6

Input/Output Resistance and Δ-Y Conversion

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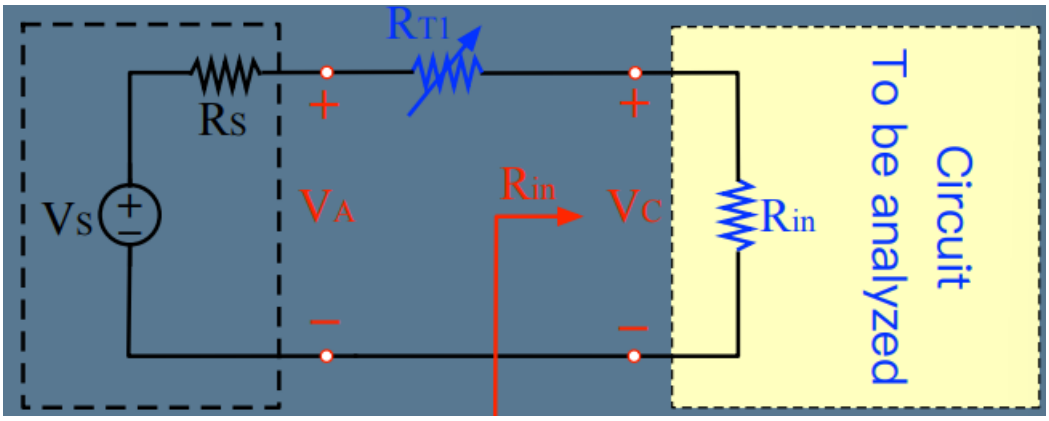
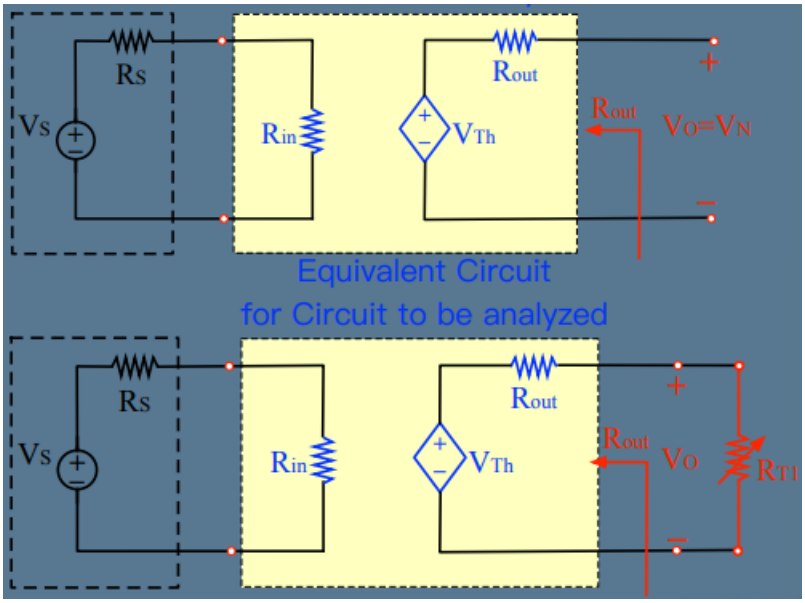
I. Introduction
   a. To learn to use the “proportional measurement method” for input and output resistance measurement
   b. To learn the experimental measurement for Wheatstone bridge and the analysis and application of Δ-Y Conversion

II. Materials
   a. DC Power Supply
   b. Digital Multimeter
   c. Components
      1. 1.1 kΩ ×2, 2.2 kΩ×2, 3.3 kΩ×2, Variable Resistor RT ×1
      2. 1 kΩ ×2, 3 kΩ ×4, 6.2 kΩ ×1

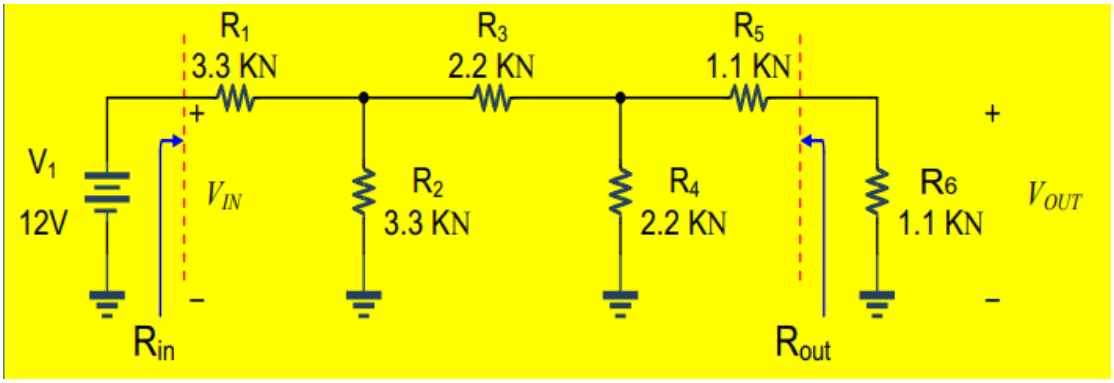
III. Circuit diagram



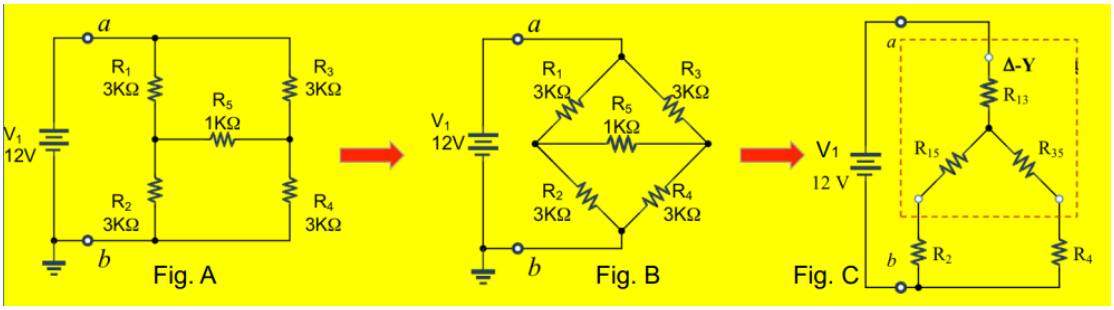
▲ Figure 1. Circuit of Experiment 6.a.1 Input Resistance



▲ Figure 2. Circuit of Experiment 6.a.2 Output Resistance



▲ Figure 3. Circuit of Experiment 6.a Input/Output Resistance Measurement



▲ Figure 4. Circuit of Experiment 6.b Δ-Y Conversion

IV. Methods

Determine the input/output resistance R_{in}/R_{out} of the circuit with Proportional Method and direct measurement.

V. Experiments data

a. Experiment 6.a Input/Output Resistance Measurement

1. Input Resistance

Table 1: Results of the V_{in} and I_{in} Measurements

V_{in}	I_{in}
12 V	0.00245 A

Table 2: Results of the R_{in} with proportional method

R_{in}(Proportional)	R_{in}(Theorem)	% Error
4912.8 Ω	4897.9592 Ω	0.30%

Table 3: Results of the R_{in} with direct measurement

R_{in}(Direct)	R_{in}(Theorem)	% Error
4914.6 Ω	4897.9592 Ω	0.34%

2. Output Resistance

Table 4: Results of the V_{out} and I_{out} Measurements

V_{out}(V)	I_{out}(A)
2.187 V	0.00089 A

Table 5: Results of the R_{in} with proportional method

R_{out}(Proportional)	R_{out}(Theorem)	% Error
2457.5 Ω	2457.3034 Ω	0.01%

Table 6: Results of the R_{in} with direct measurement

R_{out}(Direct)	R_{out}(Theorem)	% Error
2633.7 Ω	2457.3034 Ω	7.18%

b. Experiment 6.b Δ-Y Conversion

1. Based on Direct Measurement

Table 7: Measurement of practical resistance of the resistors and R_{ab}

	Measured	Theorem
R_1	2975.8 Ω	3000 Ω
R_2	2964.7 Ω	3000 Ω
R_3	2960.1 Ω	3000 Ω
R_4	2983.5 Ω	3000 Ω
R_5	988.5 Ω	1000 Ω
R_{ab}	2972.3 Ω	3000 Ω

2. Based on Theoretical Calculation

Table 8: Calculation of equivalent resistance of R_{13}, R_{15}, and R_{35}

	Measured	Theorem
R_{13}	1272.1197 Ω	1285.7143 Ω
R_{15}	424.8135 Ω	428.5714 Ω
R_{35}	422.5722 Ω	428.5714 Ω

Table 9: Calculation of equivalent resistance of R_{ab} with different R_4

R_4	R_{ab}
1000 Ω	2274.1442 Ω
3000 Ω	2975.1010 Ω
6200 Ω	3514.1398 Ω

3. Based on Current-Voltage Measurement

Table 10: Calculation of R_{ab} by definition

R_4	I_{ab}	R_{ab}
1000 Ω	5.2971 mA	2265.3905 Ω
3000 Ω	4.0415 mA	2969.1946 Ω
6200 Ω	3.4217 mA	3507.0287 Ω

4. Bridge Current Measurement

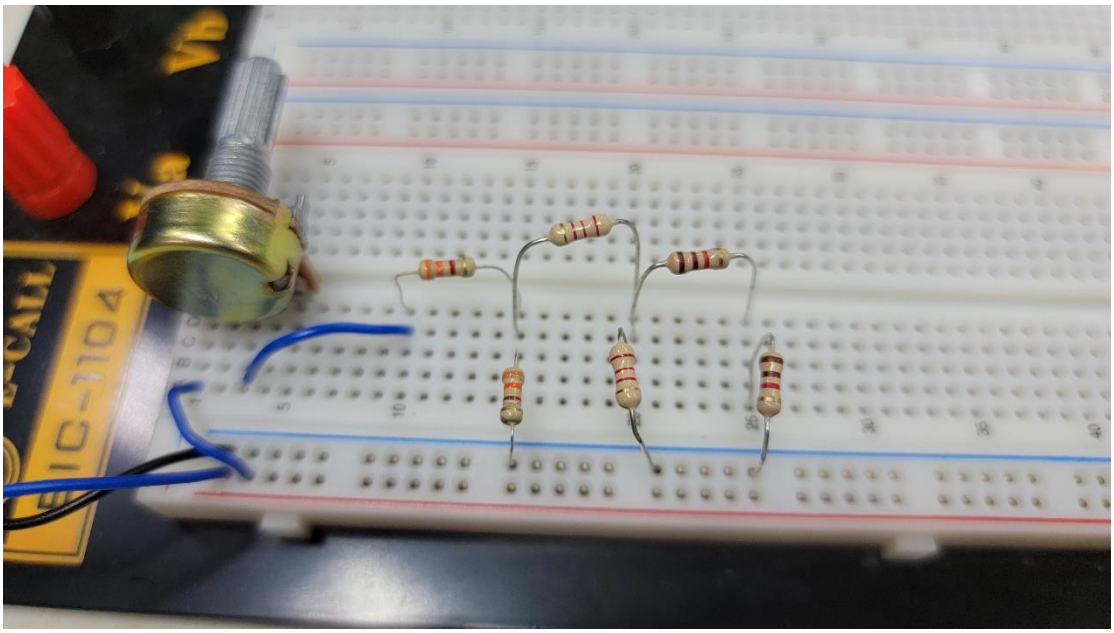
Table 11: Results of I_{R5} measurement based on different R_4

R_4	I_{R5}(mA)
1000 Ω	0.9325 mA
3000 Ω	0.0087 mA
6200 Ω	-0.4727 mA

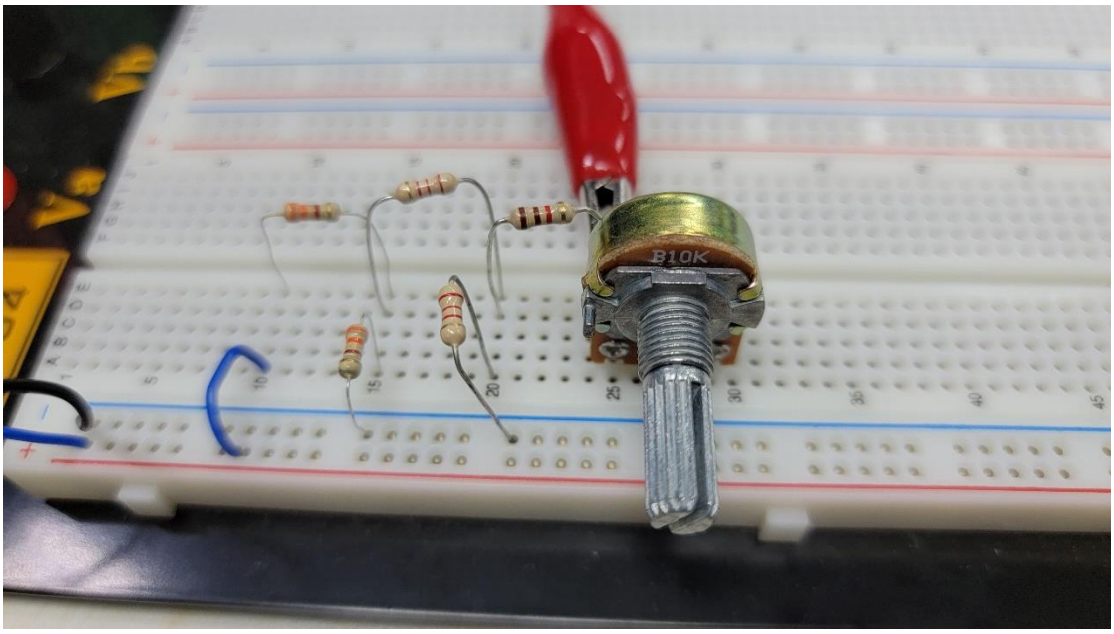
Table 12: Results of I_{R5} by applying Thevenin's Theorem

R_4	V_{Th}	R_{Th}	I_{R5}	% Error
1000 Ω	3.0000 V	2250.0000 Ω	0.9231 mA	1.021%
3000 Ω	0.0000 V	3000.0000 Ω	0.0000 mA	N/A
6200 Ω	-2.0870 V	3521.7391 Ω	-0.4615 mA	2.418%

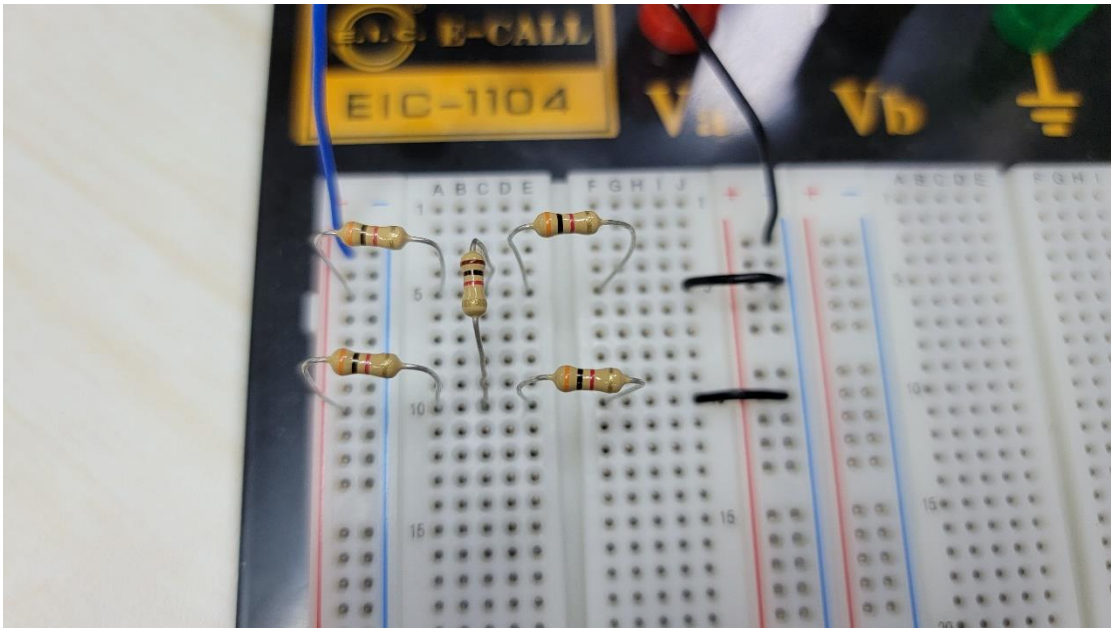
VI. Results



▲ Figure 5. Experiment 6.a.1 Input Resistance Measurement



▲ Figure 6. Experiment 6.a.2 Output Resistance Measurement



▲ Figure 7. Experiment 6.b Δ-Y Conversion

VII. Discussion

With applying Thevenin's theorem to Wheatstone bridge, the calculation of resistance and current are easy to understand and calculate.

VIII. Conclusion

Once the equivalent resistances on both side of Wheatstone bridge are unbalanced, the current will flow through. Otherwise, the current won't flow through resistance.