International Journal of Precious Engineering Research and Applications (IJPERA)
www.ijpera.com ISSN: 2456-2734,
Volume 3, Issue 1 (Jan- May) 2018), PP. 41-45

Analysis of Direct Current Resistive Circuit by Thevenin Method for Electric Circuit Subject

Ishak Annuar[1], Mazlina Mansor Hassan[1], Ahmad Nurrizal Muhammad[1],Bibi Sarpinah Sheikh Naimullah[1],Noor Azland Jainudin[2], Dzufi Iszura Ispawi[1]
[1](Facultyof Electrical Engineering, University Teknologi MARA Sarawak, JalanMeranek 94300, Kota Samarahan Sarawak, Malaysia)
[2](Faculty of Civil Engineering, University Teknologi MARA Sarawak, JalanMeranek 94300, Kota Samarahan Sarawak, Malaysia)
Corresponding Author: Ishak Annuar

ABSTRACT: The paper presents a comparison between the calculated and measured direct current (DC) resistive circuit using Thevenin method at different DC voltages. A DC voltage (5, 11, and 16 V), breadboard, three resistors (1.11kΩ), wire, and multimeter (PM3) are used for DC power supply, constructed circuit, resistance, jumper wire, and measure voltage and resistance, respectively. The calculated and measured of Thevenin voltage at different DC voltages increased as DC voltage increased from 4.54 V to 14.54 V, and 4.48 to 14.44 V, respectively. Meanwhile, the measured of Thevenin resistance did not give significant change with the calculated value. The result showed Thevenin voltage increased as the DC voltage increased. The measured Thevenin voltage and resistance are consistent with the theoretical calculated measurement.
KEYWORDS –Thevenin method, resistive circuits, DC circuit, Thevenin resistance, Thevenin voltage

---

Date of Submission: 18-04-2018 Date of acceptance: 21-05-2018

I. INTRODUCTION

Thévenin's theorem is the powerful theorem to simplify a complex circuit by an equivalent voltage source called thevenin voltage (Vth) in series connection with an equivalent resistance or Thevenin resistance (Rth).The Vth is the voltage obtained at open circuited terminals where the unknown or known values of loads are removed from the circuit. The Rth is the resistance that the total resistance looking from removing of the load by setting all independent sources to zero value (current source is removed; voltage source is remove and replaced by wire). The removed of the load then can be connected to the Vth (by setting the theoretically result into the Dc source) and Rth that are connected in series. If terminals A and B are connected to one another, the current flowing from A to B will be Vth/Rth. This means that Rth could alternatively be calculated as Vth divided by the short-circuit current between A and B when they are connected. In circuit theory terms, the theorem allows any one-port network to be reduced to a single voltage source and single impedance [1-5].

The theorem was independently derived in 1853 by the German scientist Hermann von Helmholtz and in 1883 by Léon Charles Thévenin (1857–1926), an electrical engineer with France's national Postes et Télégraphes telecommunications organization. Thévenin's theorem is widely used to make circuit analysis simpler and to study a circuit's initial-condition and steady-state response.The theorem can also be applied to frequency domain AC circuits consisting of reactive and resistive impedances. Thevenin's theorem can be used to convert any circuit's sources and impedances to a Thévenin equivalent; use of the theorem may in some cases be more convenient than use of Kirchhoff's circuit laws [6-12]. However, in this study, we are using DC voltage source. In this study, we will study direct current resistive circuit solved by the Thevenin equivalent circuit at different voltage sources. The Thevenin equivalent circuit at different voltage source are rarely been reported.

II. METHODOLOGY

The DC resistive circuit is shown in Fig. 1. It consists of 3 different values of resistor level as R1, R2, and R3, respectively. For Thevenin equivalent circuit as shown in Fig. 1, breadboard, jumper wire, resistors (R1=1 kΩ, R3=10kΩ, and R2=200 Ω), ohmmeter, voltmeter, and dc voltage are implemented in the study. DC power supply is varied from 5 to 12 V to obtain the Thevenin voltage and Thevenin resistance, restively.The Thevenin resistance, Thevenin voltage of direct current (dc) resistive circuit is compared by calculating and measurement method.

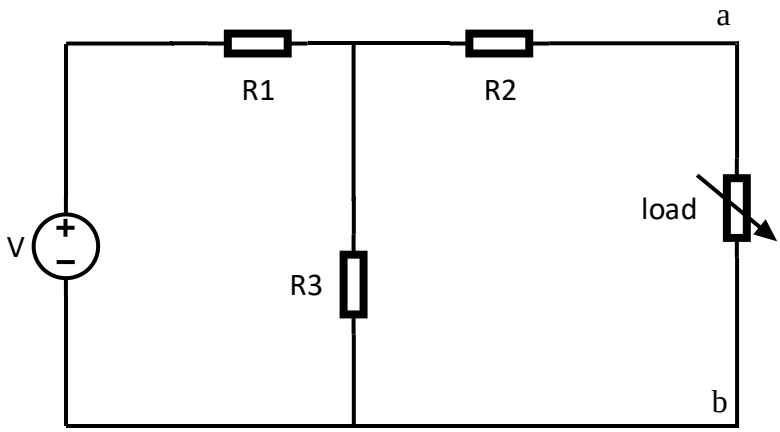
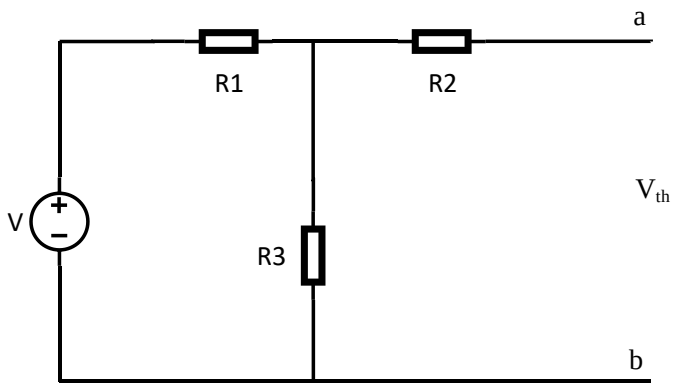
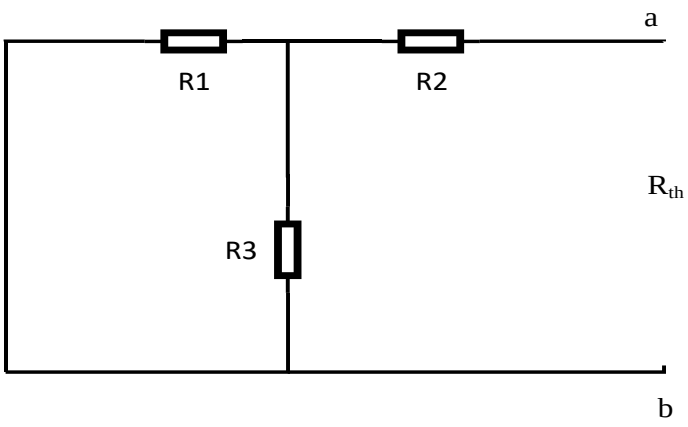


Fig.1 The dc resistive circuit

The Thevenin voltage and Thevenin resistance are connected in series with load resistance. In addition, the Thevenin voltage is theoretically calculated at terminal a-b as shown in Fig. 2 (i)by removing the load resistance. The terminal a-b is the open circuit voltage and symbol as V_{th}. The Thevenin voltage is the voltage drop across resistance R3 since the voltage drop across R2 is considered zero volt. The voltage divider rule on the other hand, can be used to calculate the voltage drop across R3.



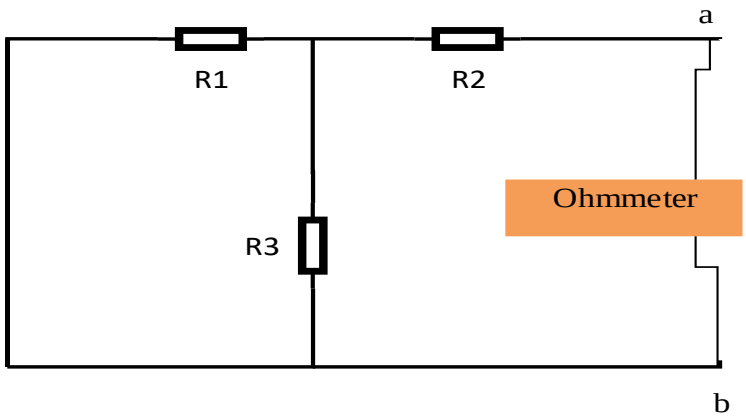
(i)



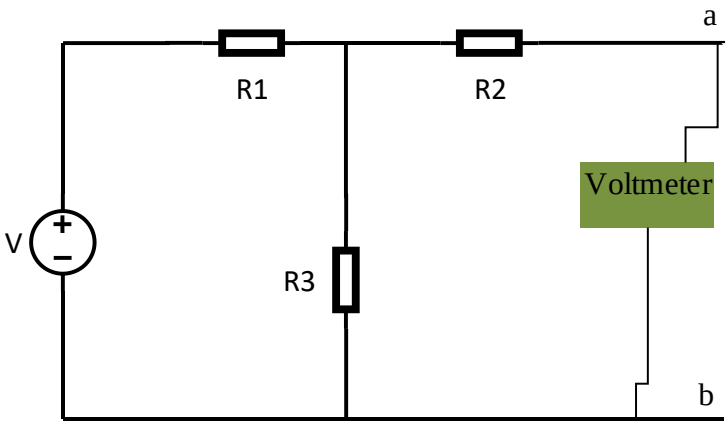
(ii)

Fig.2 The theoretical calculated of (i) Thevenin voltage and (ii) Thevenin resistance

Meanwhile, the Thevenin resistance is obtained by calculating the resistance looking at point a-b. Note that, all the DC voltage source is set to be zero volt. Ohmmeter and voltmeter are used to measure the Thevenin resistance and Thevenin voltage, respectively as shown in Fig. 3. The DC circuit configuration for measure the Thevenin resistance and Thevenin voltage is depicted in Fig. 3 (i) and (ii).



(i)



(ii)

Fig.3 The measured technique of (i) Thevenin resistance and (ii) Thevenin voltage

III. RESULTS AND DISCUSSION

The Thevenin voltage of DC circuit is shown in Fig. 4. As can be seen in Fig. 4. Three different values of resistors 1kΩ, 200 Ω, and 10 kΩ are used at different DC voltage (5V,11V, and 16V). The calculated Thevenin voltage (V_{th1}, V_{th2}, and V_{th3}) is calculated by using voltage divider rule as shown below; Since no current flow through 200Ω, the voltage dropped across 200Ω is zero. The complete result of the calculated and measured Thevenin voltage and resistance are tabulated in Table 1. It is observed that, the measured Thevenin voltage value increased from 4.48V to 14.44V as the DC voltage increased from 5V to 16V. However, the exact value (calculated value) from 4.54V to 14.54V is slightly higher than measured value. As DC voltage source increased, the Thevenin voltage is also increased. However, the Thevenin resistance does not change as voltage increased. This phenomenon is consistent with theoretical calculated result as reported by others [2,6,9]. The measuring Thevenin voltage and Thevenin resistance is comparable with the theoretical calculated result as shown in Table 1, confirmed the measurement method is correct. The small error is due to small tolerances of equipment voltage source, voltmeter and resistors.

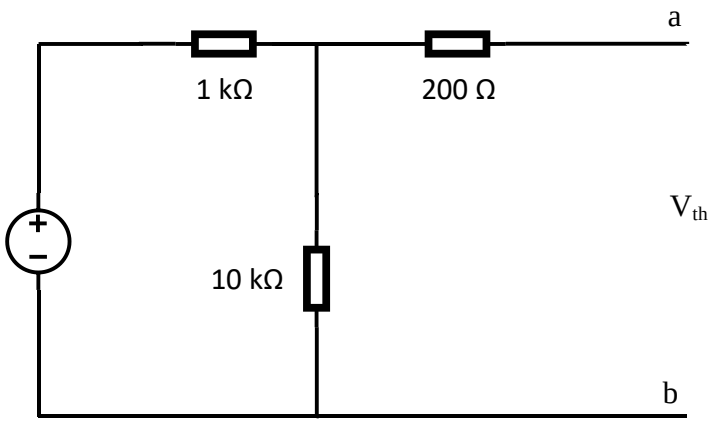


Fig.4 The Thevenin voltage of DC circuit

Using voltage divider rule (VDR)

$V_{th1} = \frac{R_3}{(R_3+R_1}(5)$= 4.54 V

$V_{th2} = \frac{R_3}{(R_3+R_1}(11)$= 11.14 V

$V_{th3} = \frac{R_3}{(R_3+R_1}(16)$= 14.54 V

Thevenin resistance

$R_{th} = \frac{(R_3)*(R_1)}{(R_3+R_1)} + R_2$= 1.11kΩ

Table 1. The calculated and measured value of Thevenin voltage and resistance at different DC voltages

DC voltage	**Calculated**		**Measured**	
(V)	**Vth (V)**	**Rth (kΩ)**	**Vth (V)**	**Rth (Ω)**
5 (4.93)	**4.54**	**1.11**	**4.48**	**1.125**
11 (11.09)	**11.14**	**1.11**	**11.09**	**1.125**
16 (15.88)	**14.54**	**1.11**	**14.44**	**1.125**

IV. CONCLUSION

The paper presents a study on Thevenin equivalent circuit between the calculated and measured of direct current (DC) resistive circuit using at different DC voltages. The calculated and measured of Thevenin voltage at different DC voltages increased as DC voltage increased from 4.54 V to 14.54 V, and 4.48 to 14.44 V, respectively. Meanwhile, the measured of Thevenin resistance did not give significant change with the calculated value proved the successfully of Thevenin method for obtain the value of voltage and resistance. The measured Thevenin voltage and resistance are consistent with the theoretical calculated measurement.

REFERENCES

[1]. Teschke, Omar, David Mendez Soares, andJuracyrFerraz Valente Filho, Floating liquid bridge tensile behavior: Electric-field-induced Young's modulus measurements, Applied Physics Letters 103.25, 2013, 251608.
[2]. BAI, Feng-xian, Wei-jie DONG, and Yan-hong JIANG. Study on Teaching of Electric Circuit with Controlled Sources, Journal of Electrical & Electronic Education 2, 2006 009.
[3]. Rajput, Ashok Kumar, Visualization Base Simulation of DC Network Theorems in Basic Electrical Engineering with Lab VIEW, International Journal of Engineering and Advanced Technology 2 (2012).
[4]. HE, Jian-xin, and Li HUANG. "Discussion on Design of Teaching Thevenin's Theorem Module [J]." Journal of Wuhan Institute of Shipbuilding Technology 5 (2009): 030.
[5]. Bandyopadhyay, Anup Kumar, Thevenin's theorem: An easy proof suitable for undergraduate teaching, Lat. Am. J. Phys. Educ. 9, 2015, 2502-1.
[6]. Mohsenizadeh, Navid, et al., Linear circuits: a measurement-based approach, International Journal of Circuit Theory and Applications 43.2, 2015, 205-232.
[7]. Diffenderfer, Robert. Electronic devices: systems and applications. Cengage Learning, 2005.
[8]. Bakshi, U. A., &Bakshi, A. V. (2009). Network analysis. Technical Publications.
[9]. Bird, John. Electrical circuit theory and technology. Routledge, 2014.
[10]. Kuphaldt, Tony R. "Lessons In Electric Circuits, Volume I–DC." Vol. Fifth Edition. Open Book Project (2006).
[11]. Robbins, Allan H., and Wilhelm C. Miller. Circuit analysis: Theory and practice. Cengage Learning, 2012.
[12]. Mazda, FraidoonFramroz, ed. Electronics engineer's reference book. Butterworth-Heinemann, 2013.

[13]. Boccaletti, C., G. Duni, and E. Santini. "Extended Thévenin equivalent circuits." In 2008 International Symposium on Power Electronics, Electrical Drives, Automation and Motion. 2008.
[14]. Yuan, Haoyu, and Fangxing Li., A comparative study of measurement-based Thevenin equivalents identification methods, North American Power Symposium (NAPS), 2014. IEEE, 2014.

Ishak Annuar "Analysis of Direct Current resistive Circuitbythevenin Method for Electric Circuit Subject" International Journal of Precious Engineering Research and Applications (IJPERA), vol. 03, no. 01, 2018, pp. 41–45.