



Khulna University of Engineering & Technology

KUET

SESSIONAL REPORT

Course No. EEE 1108

Department of CSE

Experiment No. 09

Name of the Experiment Verification of Reciprocity Theorem

Remarks

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Objectives:

By performing this experiment, various things will be known. The purpose of the experiment are given below:

- ☞ To gather knowledge about the Reciprocity Theorem
- ☞ To know how same voltage and current are maintained for any combination of same elements in a circuit
- ☞ To verify the Reciprocity Theorem and be able to apply it.
- ☞ To know the connection of the circuit.
- ☞ To describe about the current flowing through a branch will vary with the emf's position.
- ☞ To measure current and thus verify the Theorem for different emf's position

Introduction:

The reciprocity theorem is unquestionably one of the most important theorem for basic electrical circuit. The Theorem states that - In any branch of a network or circuit, the current due to a single source of voltage (V) in the network is equal to the current through that branch in which the source was originally placed when the source is again put in the branch in which the current was originally obtained.

In any bilateral linear network containing one or more generators the ~~ratio~~ ratio of a voltage introduced in one mesh to the current (I) in any second mesh is the same as the ratio obtained if the position of voltage and current are interchanged other RMP being removed. The Theorem is used in electromagnetic application. While applying reciprocity

Theorem, the circuit does not have time varying elements. In simple, The location of the voltage source and the through current maybe interchange without a change in current. However, The polarity of the voltage source should be ~~inde~~ identically with the direction of branch current in each position.

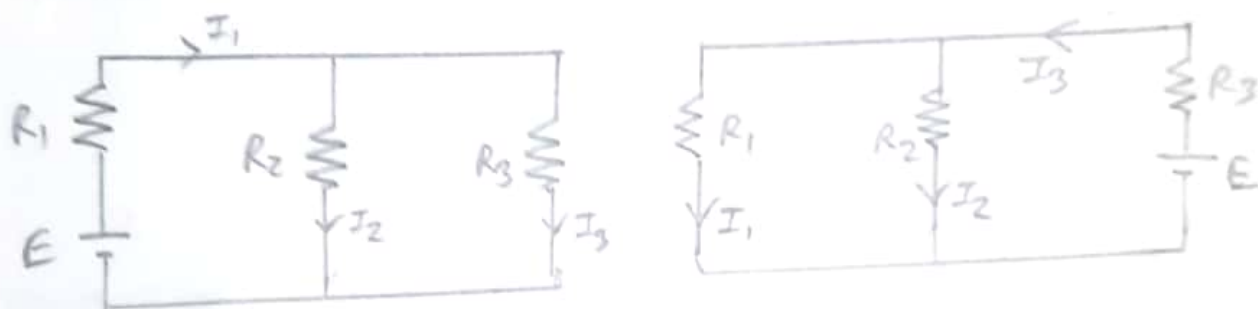


Fig 9.1: Figure shows the application of reciprocity Theorem

Apparatus Required

Table-1: The required apparatus are these:

Sl No	Name of Apparatus	Quantity	Rating.
1	DC power supply	1	0-30V, 5A.
2.	DC Ammeter	5 1	0-5A.
3.	Rheostat	3	21 Ω , 23 Ω , 100 Ω
4.	Switch	3	250 V, 6A.
5.	wire	As required	—

Experimental Setup:

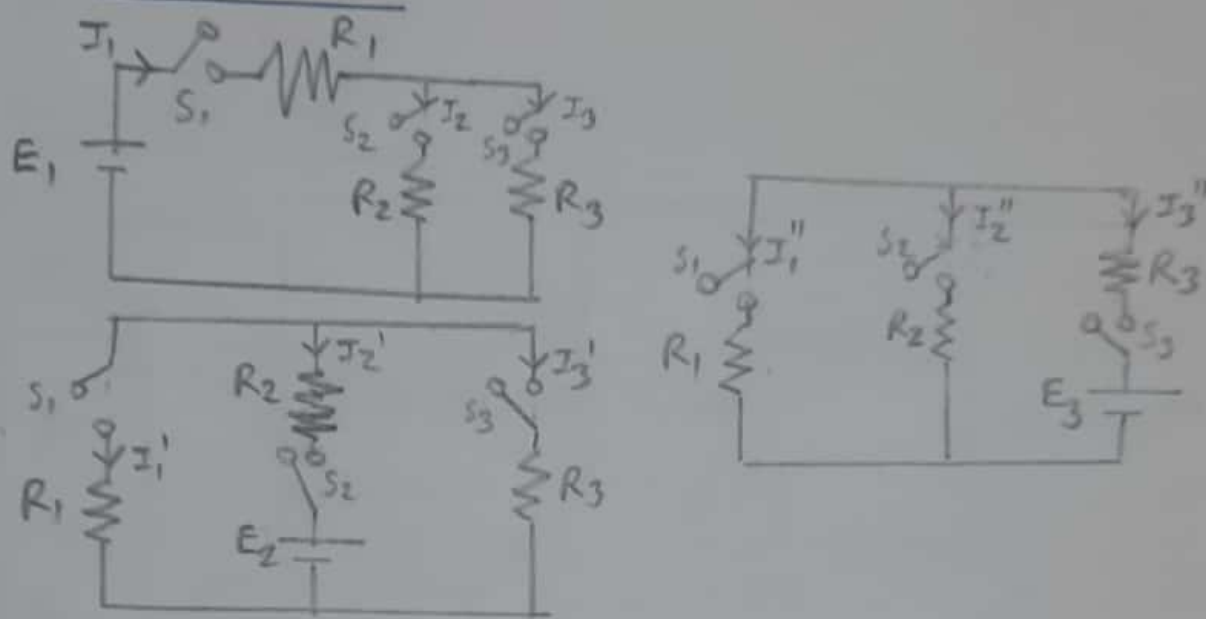


Fig 4.2 : Figure shows the circuit setup for verifying Reciprocity Theorem.

Procedure:

For doing this experiment, First Three Rheostat or resistance, a power supply, Three switch should be needed. The elements should be connected as it is in figure 4.2 (a, b, c). Then, for measuring current flowing through every resistance for two different ~~input~~ applying voltage, ~~at~~ an ammeter should be connected one ~~to~~ after one resistance in series connection. power supply will be connected with the elements.

Circuit 3

I

Experimented Data:

Resistance Applied voltage		R_1	R_2	R_3
E_1	10V	$I_1 = 0.24$	$I_2 = 0.19$	$I_3 = 0.054$
	15V	$I_1 = 0.34$	$I_2 = 0.3$	$I_3 = 0.056$
E_2	10V	$I_1' = 0.19$	$I_2' = 0.24$	$I_3' = 0.05$
	15V	$I_1' = 0.3$	$I_2' = 0.35$	$I_3' = 0.06$
E_3	10V	$I_1'' = 0.05$	$I_2'' = 0.09$	$I_3'' = 0.08$
	15V	$I_1'' = 0.056$	$I_2'' = 0.06$	$I_3'' = 0.12$

Result:

According to the reciprocity theorem,

a) $I_1 \approx I_2'$

For $E = 10V$, $I_1 = I_2' = 0.24 A$

For $E = 15V$, $I_1 = I_2 = 0.35 A$

b) $I_2 = I_1'$

For $E = 10V$, $I_2 = I_1' = 0.19 A$

For $E = 15V$, $I_2 = I_1' = 0.3 A$

$$c) I_3 = I_1'',$$

$$\text{for } E=10V, I_3 = I_1'' = 0.05 A.$$

$$\text{for } E=15V, I_3 = I_1'' = 0.056 A.$$

$$d) I_3' = I_2'',$$

$$\text{for } E=10V, I_3' = I_2'' = 0.05 A. / 0.09 A.$$

$$\text{for } E=15V, I_3' = I_2'' = 0.06 A.$$

Discussion:

In this experiment, it is proved that the location of the voltage source and the ~~the~~ through current maybe interchange without a change in current. This law is called the theorem of reciprocity. At first, A resistance has been connected with a voltage source (E) and two other resistance. Then, the current flowing through it have been measured with an ammeter. Then, the voltage source "interchanged" its position and moved in with the resistance (R_2). Then, ~~the~~ ~~th~~ it has been observed that the through ~~th~~ current ^{also} interchange

its position without a little change in current. Though, it was not absolutely same as before. The errors occur due to the long-time used ammeter and also for the wire inherent resistance. Then, the same procedure has been observed for three more ~~cases~~ cases. All the time, the reciprocity theorem maintains its property. The current interchange its position with an exact ratio ~~for~~ ^{of} $\frac{1}{n}$ to the voltage interchange. The current interchange its position without a change of value. The ~~little~~ slight errors that have been occurred can be minimised ~~with some~~ by taking some steps like changing ~~ammeter~~ ammeter or stabilising proper circuit more consciously.

Conclusion:

After finishing the experiment, a lot of experience was gathered. In this experiment, construction of complex

Circuit, knowledge of current divider rule, the constancy of energy, the property of current interchange without position without changing its value, were learnt. The theoretically stabilised reciprocity law's match results matched with the practical results, which verifies the reciprocity law.

Question And Answer:

1) Is reciprocity theorem applicable to AC circuit?

Answer: The reciprocity theorem is applicable for both AC and DC circuits.

2) What is the use of reciprocity theorem?

Answer: Forms of the theorems are used in many electromagnetic applications. Such as analyzing electrical networks and antenna system.

Reference:

- ① Quora
- ② Wikipedia
- ③ Khan Academy
- ④ electrical voice.com.