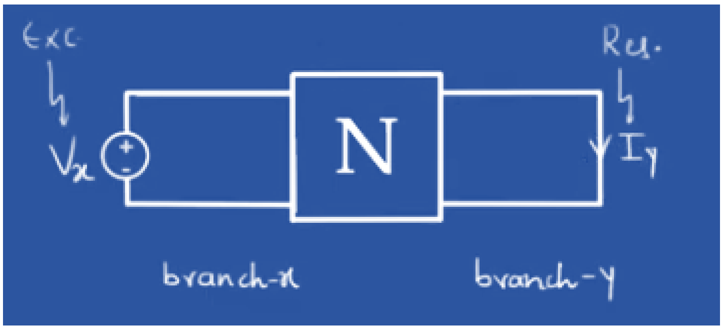
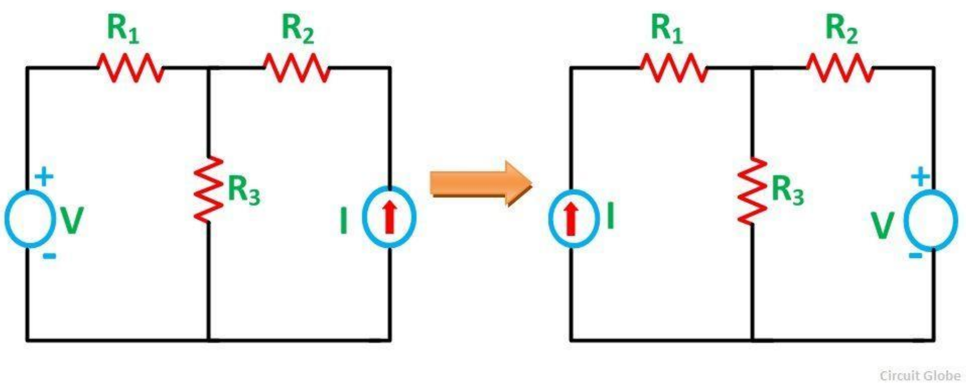
Reciprocity Theorem

In a linear bidirectional single source network, the ratio of response to excitation remains the same even when the position of response (source) and excitation are interchange or swape.



The location of the voltage source and the current source may be interchanged without a change in current. However, the polarity of the voltage source should be identical with the direction of the branch current in each position.

The Reciprocity Theorem is explained with the help of the circuit diagram shown below



The various resistances R_1, R_2, R_3 is connected in the circuit diagram above with a voltage source (V) and a current source (I). It is clear from the figure above that the voltage source and current sources are interchanged for solving the network with the help of Reciprocity Theorem.

The limitation of this theorem is that it is applicable only to single-source networks and not in the multi-source network. The network where reciprocity theorem is applied should be linear and consist of resistors, inductors, capacitors and coupled circuits.

Steps for Solving of Reciprocity Theorem

Step 1 – Firstly, select the branches between which reciprocity has to be established.

Step 2 – The current in the branch is obtained using any conventional network analysis method.

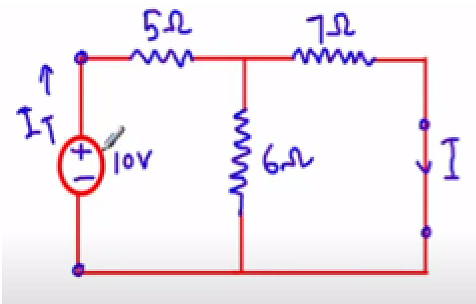
Step 3 – The voltage source is interchanged between the branch which is selected.

Step 4 – The current in the branch where the voltage source was existing earlier is calculated.

Step 5 – Now, it is seen that the current obtained in the previous connection, i.e., in step 2 and the current which is calculated when the source is interchanged, i.e., in step 4 are identical to each other.

Example

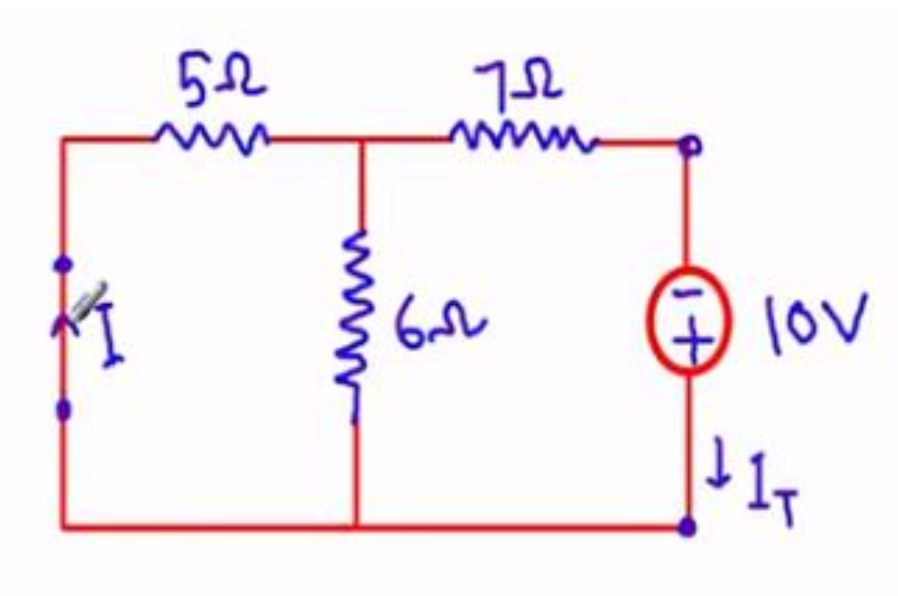
Apply reciprocity theorem in the network given below and find the value of I



$$R_T = 5 + (6 \| 7) = 5 + 3.23 = 8.23\Omega$$

$$I_T = \frac{V_T}{R_T} = 1.22\Omega$$

$$I = \frac{6}{7+6} \times 1.22 = 0.56A$$



$$R_T = 7 + (5 \| 6)$$
$$= 7 + 2.73 = 9.73\,\Omega$$
$$I_T = \frac{V_T}{R_T} = \frac{10}{9.73} = 1.03\,A$$

$$I = \frac{6}{5+6} \times 1.03 = 0.56\,A$$

Please solve same problem using Porteous