وزارة التعليم العالي والبحث العلمي
جامعة المستقبل

LEC : EIGHT

Course Name : Fundamentals of Electricity Instructor
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Stage : First
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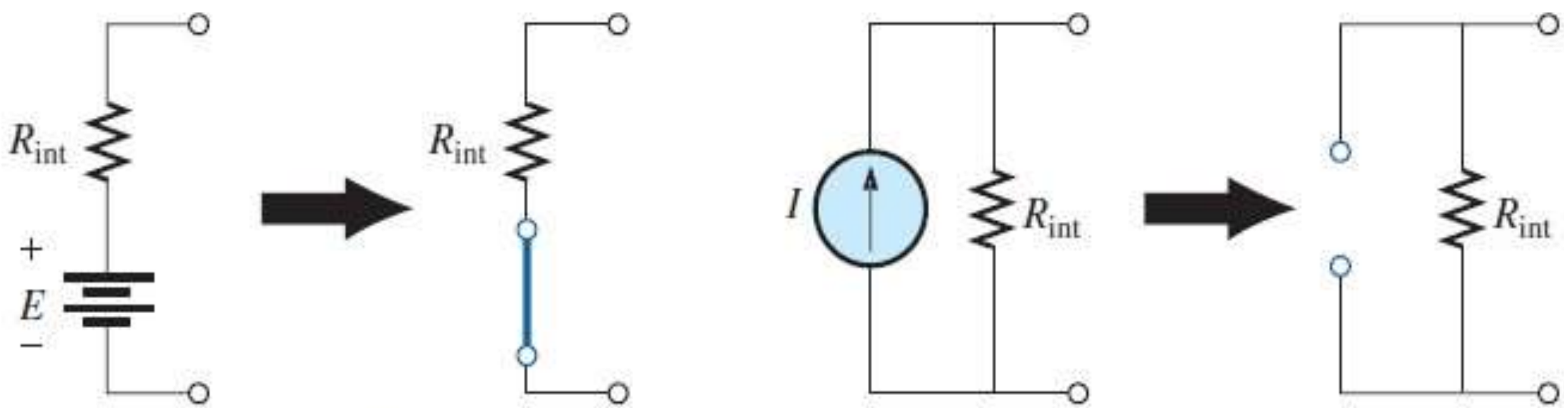
Lecture Title : **SUPERPOSITION THEOREM**

NETWORK THEOREMS (DC)

9.2 SUPERPOSITION THEOREM

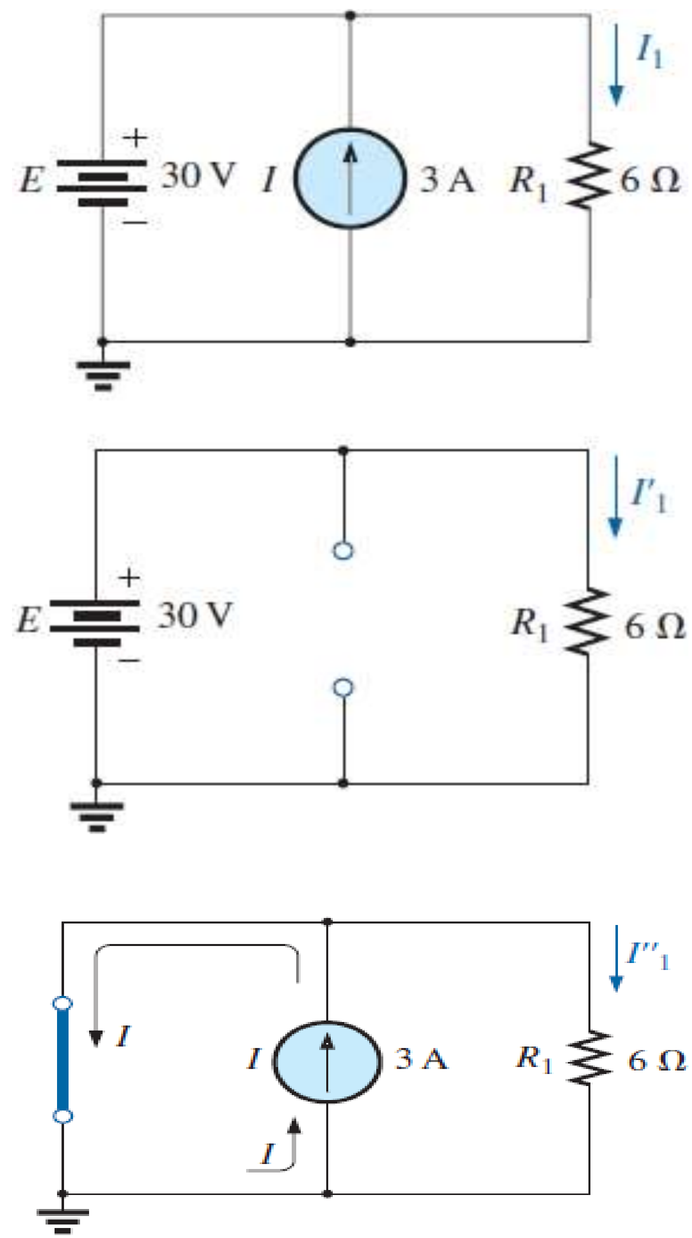
The current through, or voltage across, any element of a network is equal to the algebraic sum of the currents or voltages produced independently by each source.

When removing a voltage source from a network schematic, replace it with a direct connection (short circuit) of zero ohms. Any internal resistance associated with the source must remain in the network.
When removing a current source from a network schematic, replace it by an open circuit of infinite ohms. Any internal resistance associated with the source must remain in the network.



Removing a voltage source and a current source to permit the application of the superposition theorem.

EXAMPLE 9.1 Using the superposition theorem, determine current *I1* for the network in Fig.



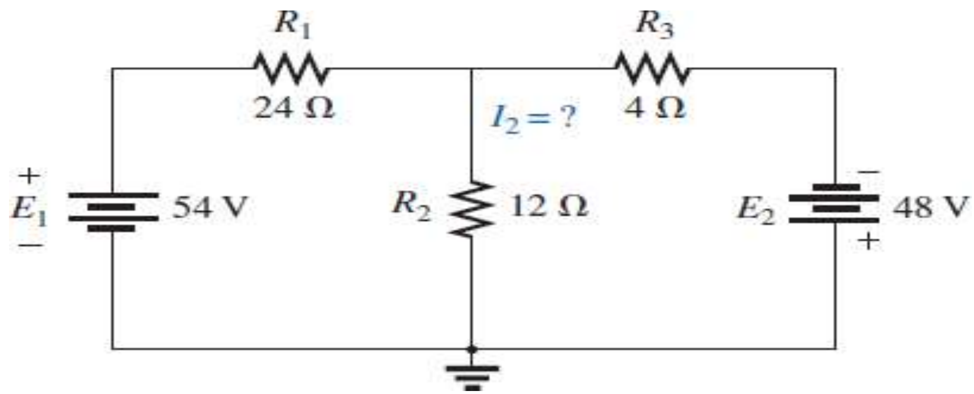
Due to the open circuit, resistor *R1 is in series*

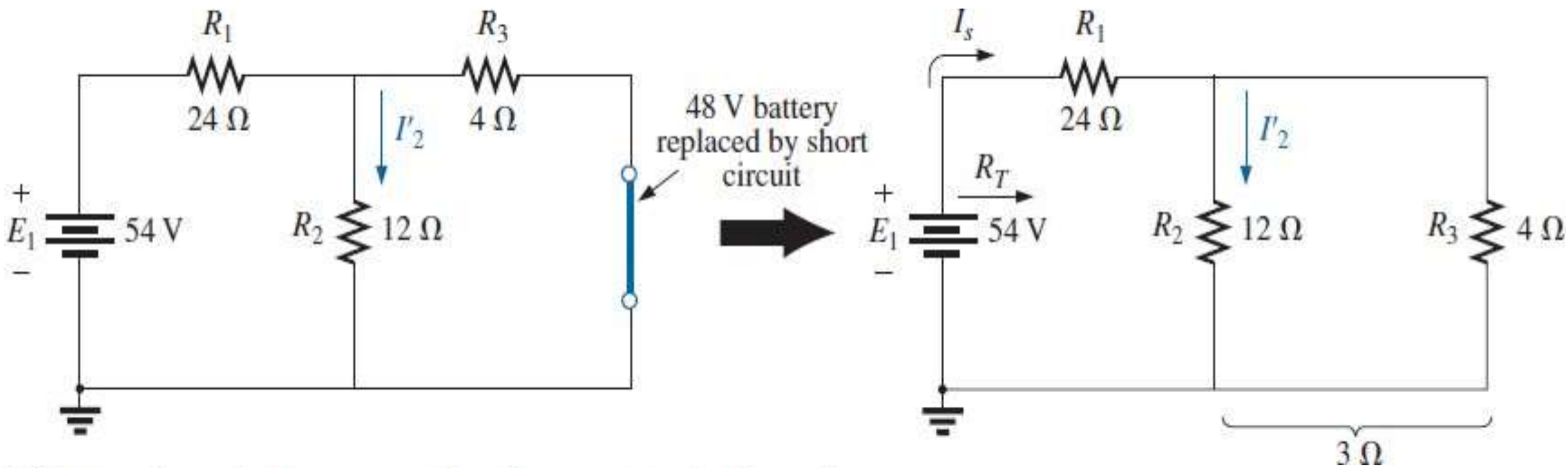
$$I'_1 = \frac{V_1}{R_1} = \frac{E}{R_1} = \frac{30\text{ V}}{6\ \Omega} = 5\text{ A}$$

$$I''_1 = \frac{R_{sc}I}{R_{sc} + R_1} = \frac{(0\ \Omega)I}{0\ \Omega + 6\ \Omega} = 0\text{ A}$$

$$I_1 = I'_1 + I''_1 = 5\text{ A} + 0\text{ A} = \mathbf{5\text{ A}}$$

EXAMPLE 9.2 Using the superposition theorem, determine the current through the 12 Ω resistor in Fig. Note that this is a two-source network of the type examined in the previous chapter when we applied branch-current analysis and mesh analysis.





The total resistance seen by the source is therefore

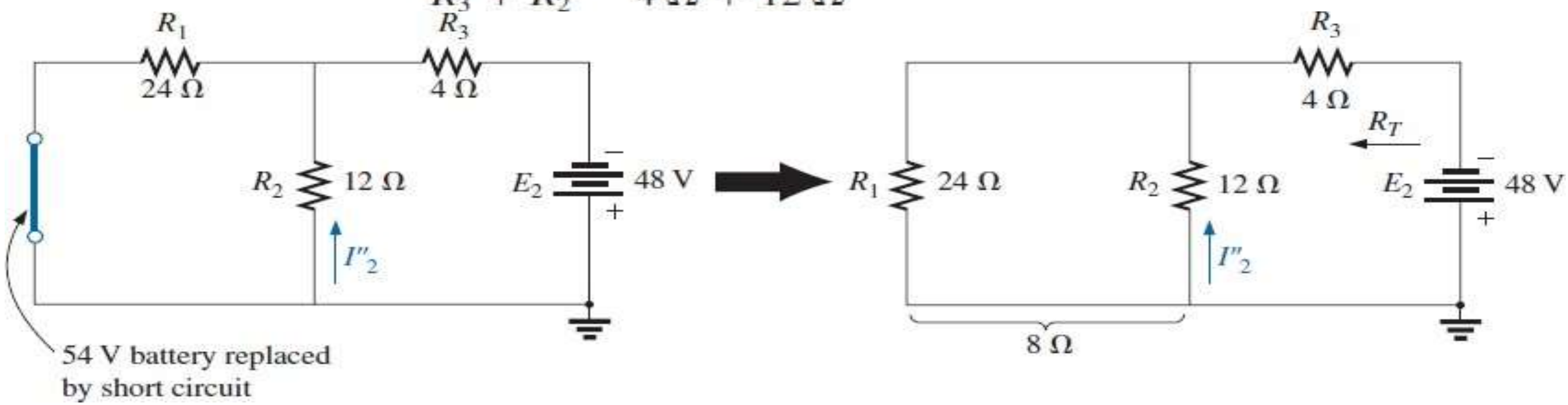
$$R_T = R_1 + R_2 \| R_3 = 24\ \Omega + 12\ \Omega \| 4\ \Omega = 24\ \Omega + 3\ \Omega = 27\ \Omega$$

and the source current is

$$I_s = \frac{E_1}{R_T} = \frac{54\ \text{V}}{27\ \Omega} = 2\ \text{A}$$

Using the current divider rule results in the contribution to I_2 due to the 54 V source:

$$I'_2 = \frac{R_3 I_s}{R_3 + R_2} = \frac{(4\ \Omega)(2\ \text{A})}{4\ \Omega + 12\ \Omega} = 0.5\ \text{A}$$



Therefore, the total resistance seen by the 48 V source is

$$R_T = R_3 + R_2 \| R_1 = 4\ \Omega + 12\ \Omega \| 24\ \Omega = 4\ \Omega + 8\ \Omega = 12\ \Omega$$

and the source current is

$$I_s = \frac{E_2}{R_T} = \frac{48\ \text{V}}{12\ \Omega} = 4\ \text{A}$$

Applying the current divider rule results in

$$I''_2 = \frac{R_1(I_s)}{R_1 + R_2} = \frac{(24\ \Omega)(4\ \text{A})}{24\ \Omega + 12\ \Omega} = 2.67\ \text{A}$$

It is now important to realize that current *I2 due to each source has a* different direction, as shown in Fig. The net current therefore is the difference of the two and the direction of the larger as follows:

$$I_2 = I''_2 - I'_2 = 2.67\ \text{A} - 0.5\ \text{A} = \mathbf{2.17\ A}$$