ELEMENTS OF ELECTRICAL ENGINEERING

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Concept of Linearity; Superposition Theorem

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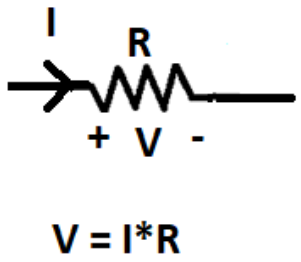
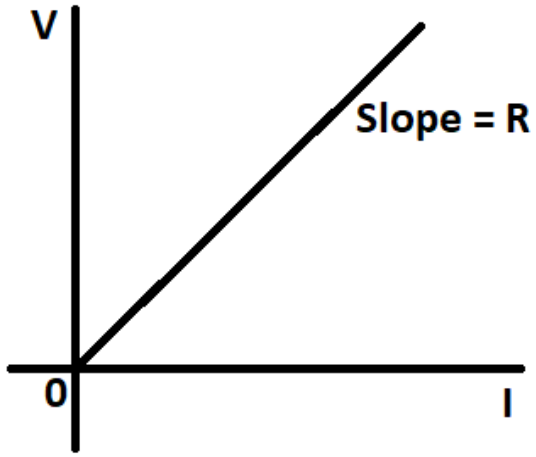
Linear Elements and Linear Circuits

A linear element is a passive element with linear voltage-current relationship.

Resistors, Inductors & Capacitors are linear elements.



V = I*R



A linear circuit is one which is composed of linear elements, independent sources & linear dependent sources.

Superposition Theorem - Statement

Superposition Theorem is applicable to Linear networks.

It can be stated as follows:

"In a linear network with more than one independent source, the total response in any element is the algebraic sum of the individual responses caused by each independent source acting alone, while all other independent sources are replaced by their internal resistances i.e., all other ideal voltage sources with short circuit and all other ideal current sources with open circuit."

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Procedure to apply Superposition Theorem

Step 1: Consider one of the independent sources.

Step 2: Replace all other independent voltage sources with short circuit and all other independent current sources with open circuit.

Step 3: Find the individual response in the desired element due to the considered source acting alone.

Step 4: Repeat Steps 1, 2 & 3 until all the sources are considered.

Step 5: Add all individual responses algebraically to get the total response.

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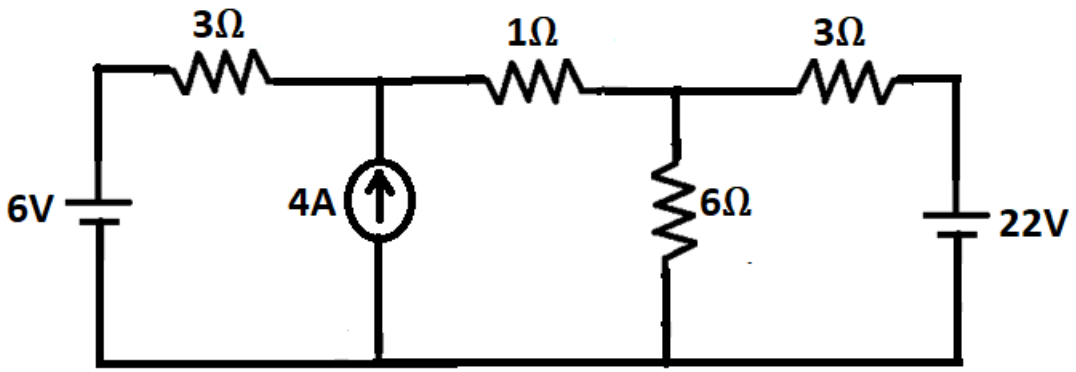
Numerical Example 1

Question:

Obtain current through 1Ω resistor using Superposition Theorem.



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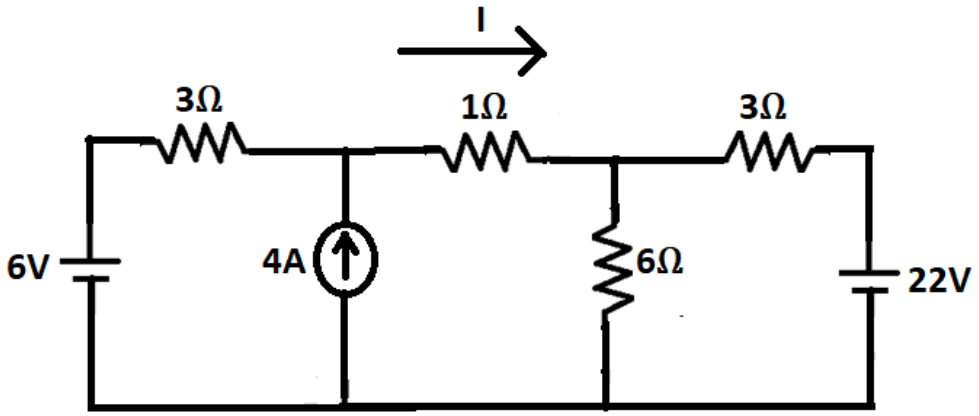
Numerical Example 1

Solution:



Let us consider individual response due to 6V source acting alone as I'

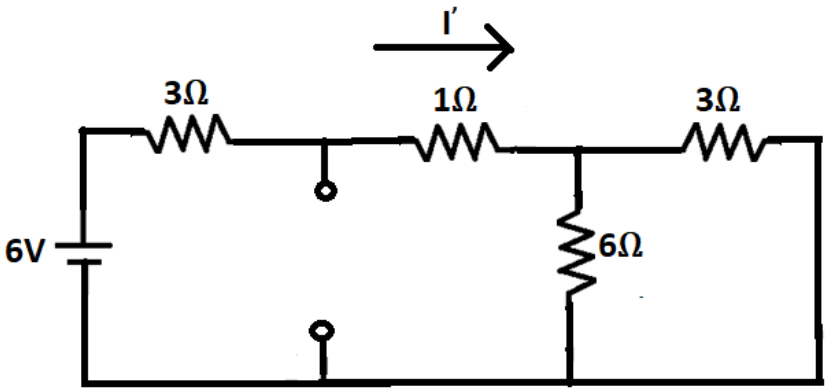
Let us consider individual response due to 4A source acting alone as I''

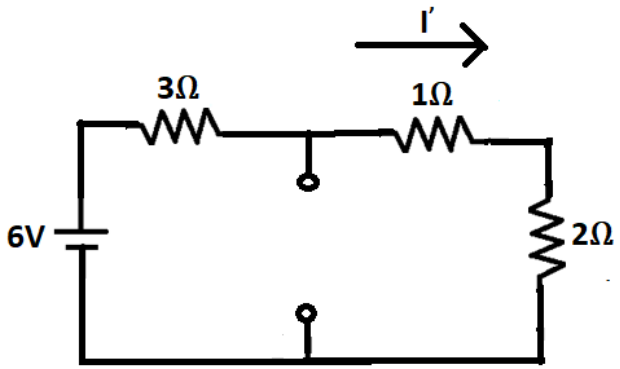
Let us consider individual response due to 22V source acting alone as I'''

Numerical Example 1

Solution (Continued..) :

Considering 6V source alone,



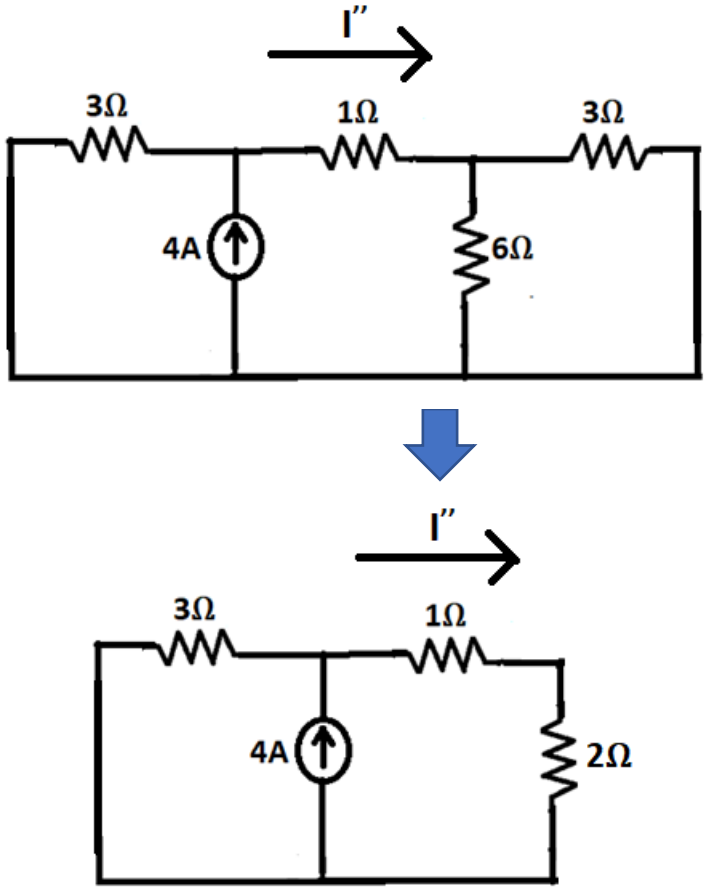


$$I' = \frac{6V}{6\Omega} = 1A$$

Numerical Example 1

Solution (Continued..) :

Considering 4A source alone,

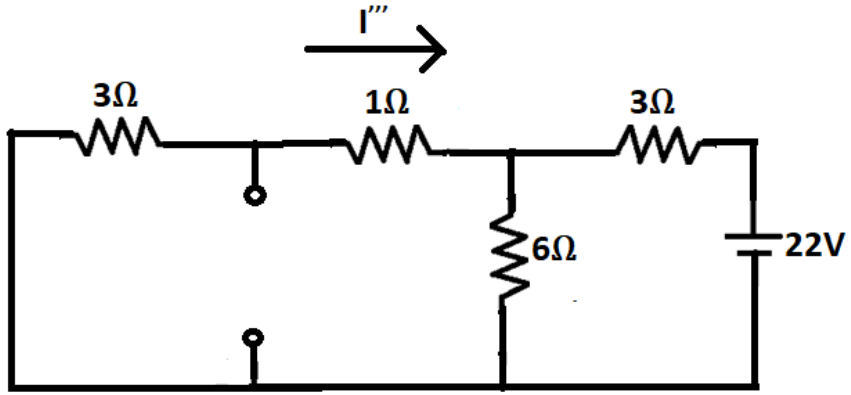


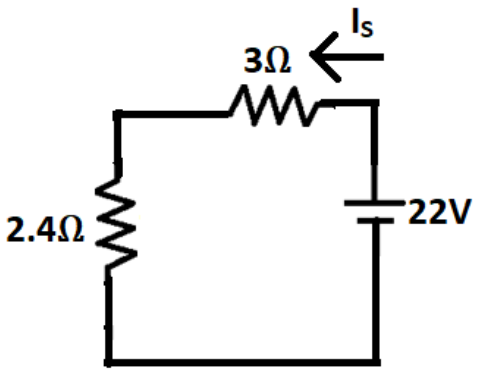
$$I'' = 4A * \frac{3\Omega}{6\Omega} = 2A$$

Numerical Example 1

Solution (Continued..) :

Considering 22V source alone,

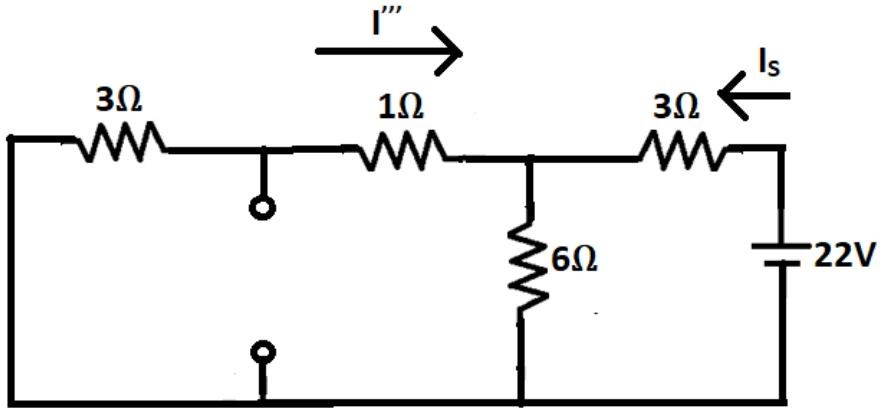




$$I_S = \frac{22V}{5.4\Omega} = 4.074A$$

Numerical Example 1

Solution (Continued..) :



$$I''' = -I_S * \frac{6\Omega}{10\Omega} = -2.44A$$

By Superposition Theorem,

$I = I' + I'' + I'''$

Hence, I = 0.56A

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Text Book & References

Text Book:

"Electrical and Electronic Technology" E. Hughes (Revised by J. Hiley, K. Brown & I.M Smith), 11th Edition, Pearson Education, 2012.

Reference Books:

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2. "Basic Electrical Engineering - Revised Edition", D. C. Kulshreshta, Tata- McGraw-Hill, 2012.
3. "Engineering Circuit Analysis", William Hayt Jr., Jack E. Kemmerly & Steven M. Durbin, 8th Edition, McGraw-Hill, 2012.

THANK YOU

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