NOTES – CLASS 12

Concept of Linearity:
A linear element is a passive element with linear voltage-current relationship.
Resistors, Inductors & Capacitors are linear elements.

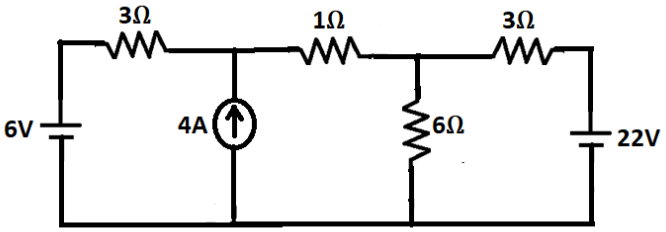
For instance, resistor obeys Ohm's Law which is a linear voltage current relationship. Inductors and Capacitors have voltage current relationship which is a linear differential equation. Hence, these elements are linear.

A linear circuit is one which is composed of linear elements, independent sources & linear dependent sources.
One of the major advantages of linear networks is that they satisfy the property of Superposition.

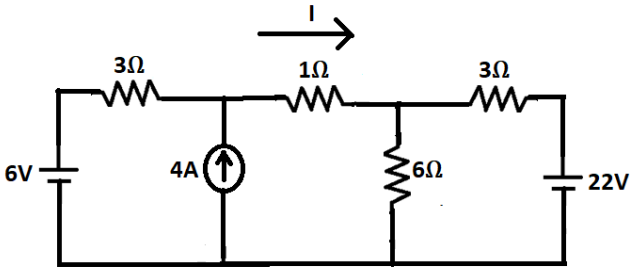
Superposition Theorem:
Statement:
"In a linear network with more than one independent source, the total response in any element is the algebraic sum of the individual responses caused by each independent source acting alone, while all other independent sources are replaced by their internal resistances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

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.

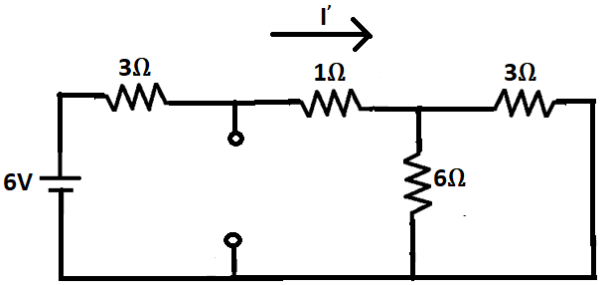
Numerical Example 1: Obtain current through 1Ω resistor using Superposition Theorem.

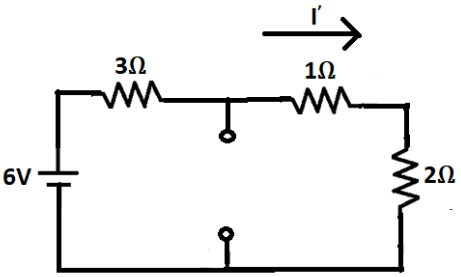


Solution: Let I be the current through 1Ω resistor as shown below:



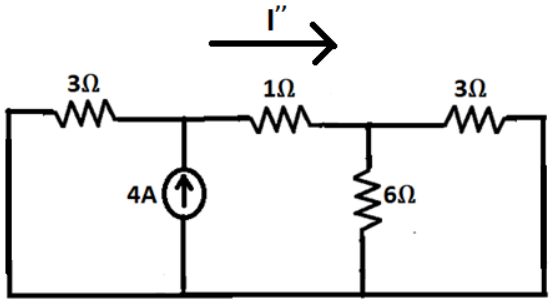
Let us consider individual response due to 6V source acting alone as I'
Let us consider individual response due to 4A source acting alone as I''
Let us consider individual response due to 22V source acting alone as I'''
Considering 6V source alone,



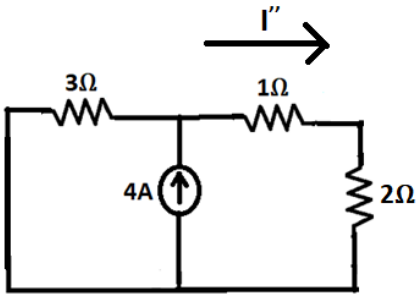


Hence, $I' = \frac{6V}{6\Omega} = 1A$

Now, Considering 4A source alone,

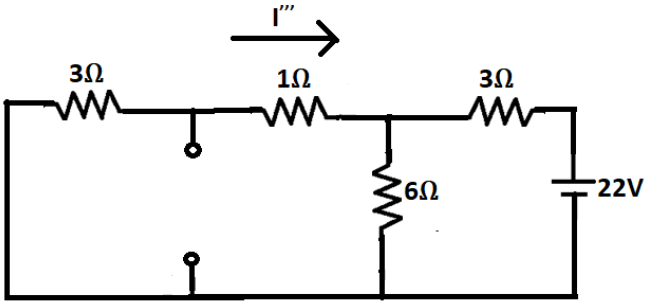


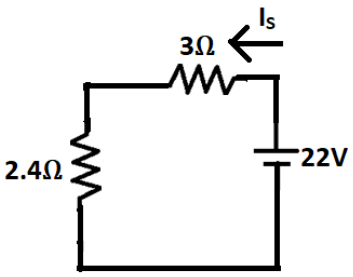
The above network gets simplified as



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

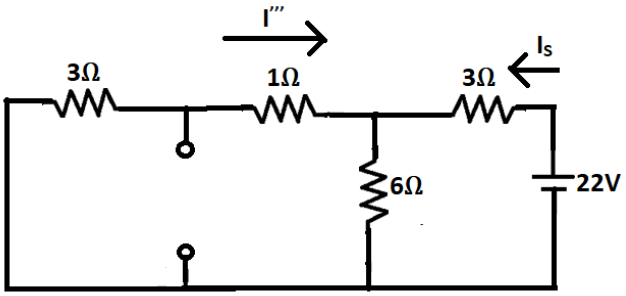
Now, Considering 22V source alone,





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

Therefore, I''' can be obtained as



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

By Superposition Theorem,

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

Hence, I = 0.56A