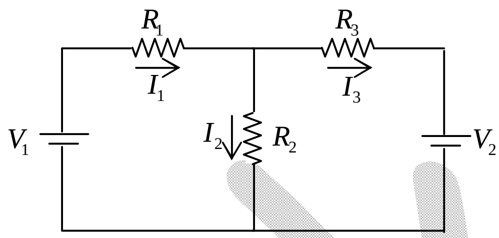
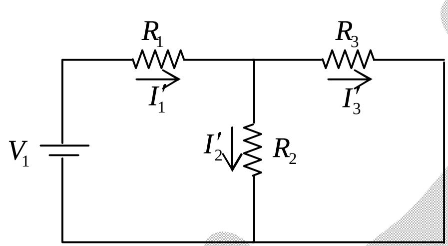
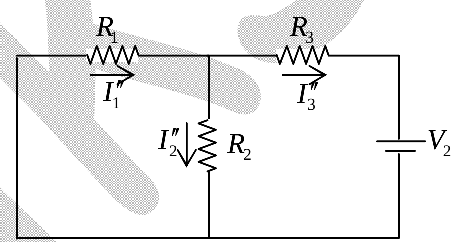
1(b). Superposition Theorem

The superposition theorem states that in a network with two or more sources the current or voltage for any component is the algebraic sum of the effects produced by each source acting independently. In order to use one source at a time, all other sources are removed from the circuit or voltage source is removed by replacing it with a short circuit. A current source is removed by replacing it with an open circuit.







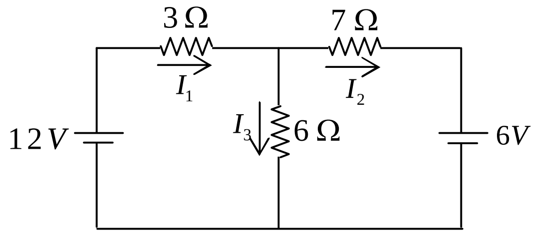
$$I_1' = \frac{V_1}{R_1 + R_2 R_3/(R_2 + R_3)} \qquad I_3'' = \frac{V_2}{R_3 + R_1 R_2/(R_1 + R_2)}$$

$$I_2' = \frac{R_3}{R_2 + R_3} I_1' \text{ and } I_3' = \frac{R_2}{R_2 + R_3} I_1' \qquad I_2'' = \frac{R_1}{R_1 + R_2} I_3'' \text{ and } I_1'' = \frac{R_2}{R_1 + R_2} I_3''$$

Direction of currents shown in figure are assumed directions, actual direction may be different.

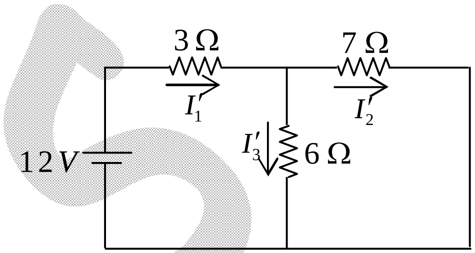
Thus $I_1 = I_1' + I_1''$; $\quad I_2 = I_2' + I_2''$; $I_3 = I_3' + I_3''$

Example: Using Superposition theorem find current across each element for the circuit shown in figure below.



Solution:

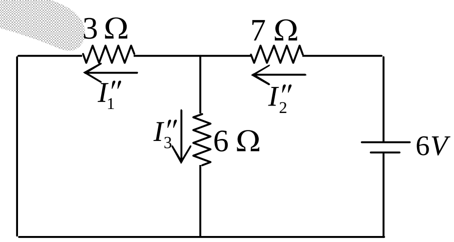
Let us find current due to individual source.



Current $I_1' = \dfrac{12}{3 + \dfrac{6\times 7}{6+7}} = \dfrac{52}{27} A$

$I_2' = \dfrac{6}{6+7} \times \dfrac{52}{27} = \dfrac{8}{9} A$ and $I_3' = \dfrac{7}{6+7} \times \dfrac{52}{27} = \dfrac{28}{27} A$

Let us find current due to second source.



Current $I_2'' = \dfrac{6}{7 + \dfrac{6\times 3}{6+3}} = \dfrac{2}{3} A$

$I_1'' = \dfrac{6}{6+3} \times \dfrac{2}{3} = \dfrac{4}{9} A$ and $I_3'' = \dfrac{3}{6+3} \times \dfrac{2}{3} = \dfrac{2}{9} A$

Thus

$I_1 = I_1' - I_1'' = \dfrac{52}{27} - \dfrac{4}{9} = \dfrac{40}{27} A,$ $\quad I_2 = I_2'' - I_2' = \dfrac{8}{9} - \dfrac{2}{3} = \dfrac{2}{9} A$

and $I_3 = I_3' + I_3'' = \dfrac{28}{27} + \dfrac{2}{9} = \dfrac{34}{27} A$