Republic of Iraq

Ministry of Higher Education

and Scientific Research

Al-Mustaqbal University College

Computer Engineering Techniques Department

Subject: Fundamentals of Electrical Engineering

First Class

Lecture Six

By

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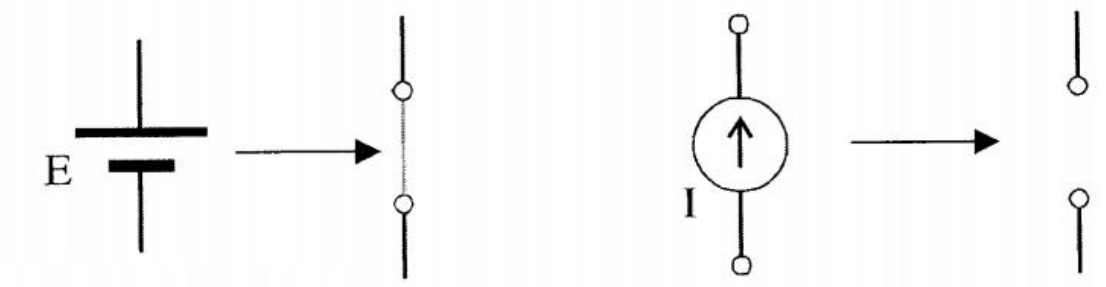
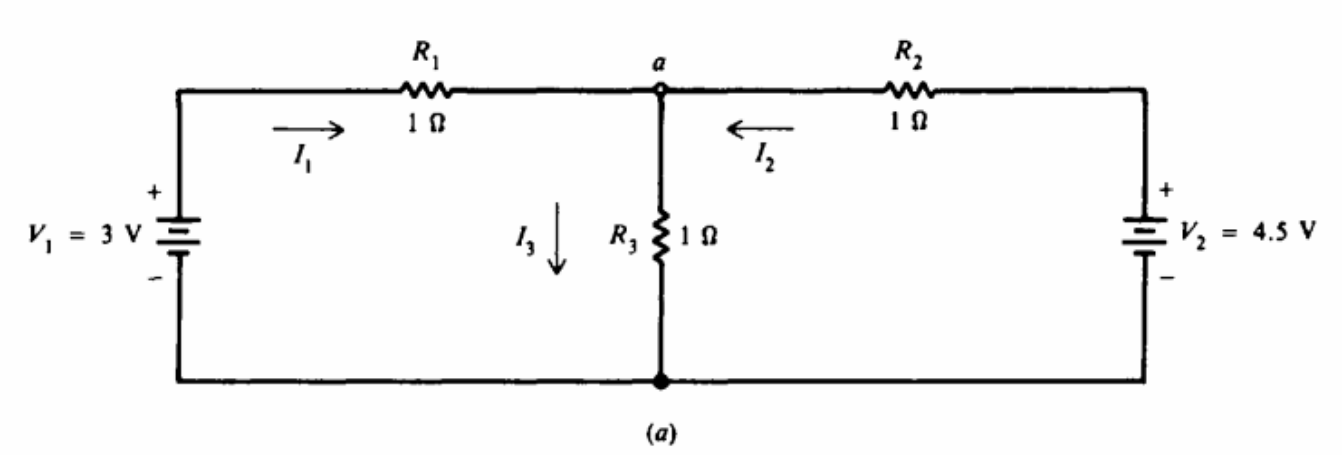
نظرية التراكيب Superposition Theorem

تستخدم نظرية التراكيب لتحليل الدوائر الكهربائية التي تحتوي على مصدري جهد او تيار او اكثر و ميزة هذه الطريقة هي عدم استعمال الطرق الرياضية لايجاد التيارات أو الجهود مقارنه بالطرق الاخرى حيث نتعامل مع كل مصدر للجهد او التيار على حدة وفي النهاية يتم تجميع الحلول لنحصل على حل نهائي و الحصول على النتائج المطلوبة من الدائرة.

في خطوات الحل يتم حذف مصدر الجهد و استبداله بدائرة مغلقة (Short Circuit), ويستبدل مصدر التيار بدائرة مفتوحة(Open Circuit).

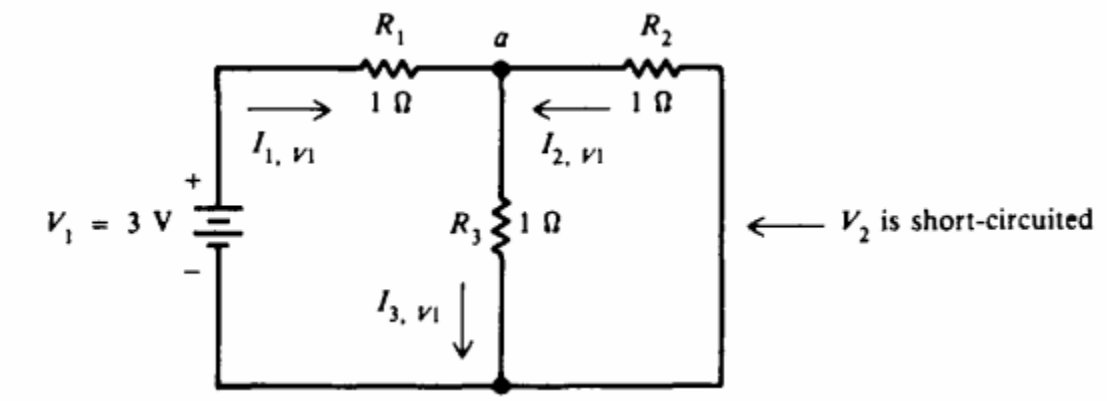


Example 1: Find branch currents **I_1, I_2,**and **I_3**by the superposition theorem



(a)

Solution: Find the currents produced by voltage source **V_1**only. Replace voltage source **V_2** with a short circuit



In order to calculate the value of I_1 we find the equivalent resistance

$$R_2//R_3 = \frac{R}{n} = \frac{1}{2}\ \Omega$$

$$R_T = R_1 + R_2//R_3$$

$$R_T = 1 + \frac{1}{2} = 1.5\ \Omega$$

The value of I_1 produced by V_1

$$I_{1,V1} = \frac{V_1}{R_T} = \frac{3}{1.5} = 2\ A$$

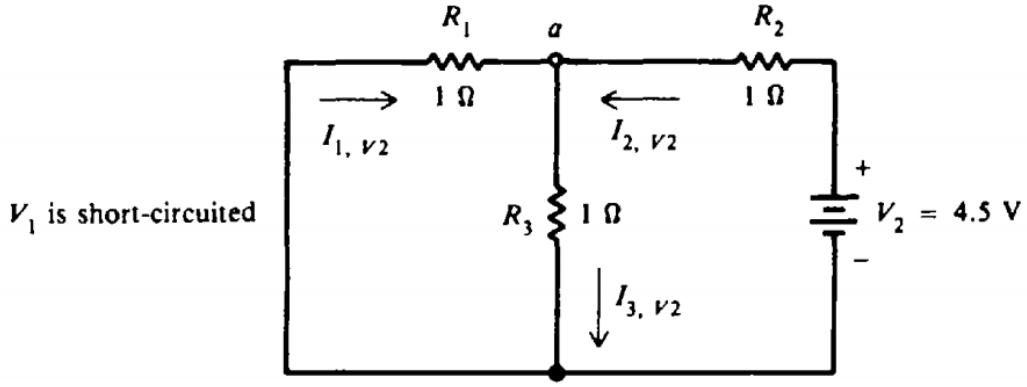
The value of I_2 and I_3 that produced by V_1 are

$$I_{2,v1} = -\frac{1}{2} I_{1,v1} = -\frac{1}{2} 2 = -1\ \text{A}$$

$$I_{3,v1} = \frac{1}{2} I_{1,v1} = \frac{1}{2} 2 = 1\ \text{A}$$

Find the currents produced by voltage source $\mathbf{V_2}$ only.

Replace voltage source $\mathbf{V_1}$ with a short circuit



$$R_T = 1.5\ \Omega$$

$$I_{2,V2} = \frac{V_2}{R_T} = \frac{4.5}{1.5} = 3\ A$$

$$I_{1,V2} = -\frac{1}{2} I_{2,V2} = -\frac{3}{2} = -1.5\ A$$

$$I_{3,V2} = \frac{1}{2} I_{2,V2} = \frac{3}{2} = 1.5\ A$$

So that the value of I_1 is

$$I_1 = I_{1,V1} + I_{1,V2}$$

$$I_1 = 2 - 1.5 = 0.5 \text{ A}$$

The value of I_2 is

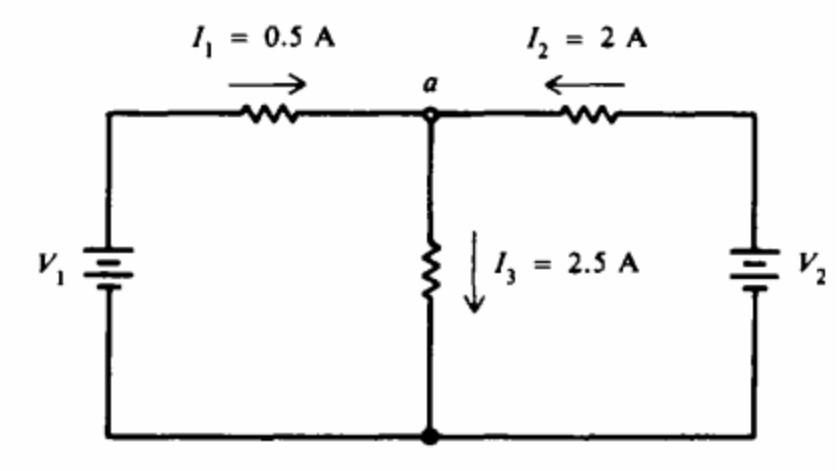
$$I_2 = I_{2,v1} + I_{2,v2}$$

$$I_2 = -1 + 3 = 2 \text{ A}$$

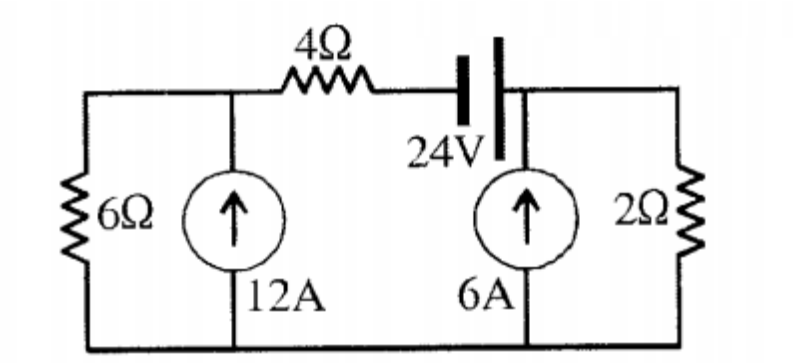
The value of I_3 is

$$I_3 = I_{3,v1} + I_{3,v2}$$

$$I_2 = 1 + 1.5 = 2.5 \text{ A}$$

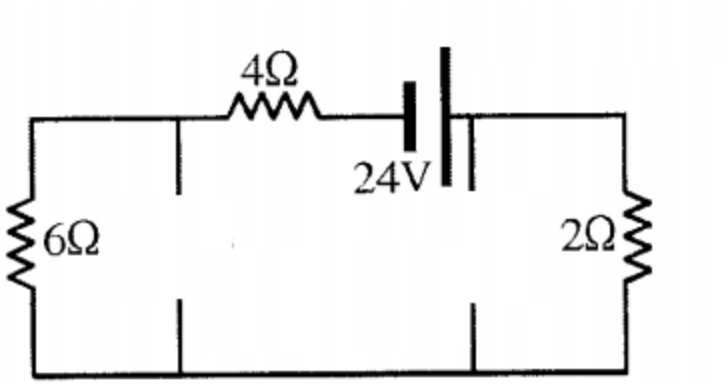


Example 2: Using superposition theorem Find the value and direction of current passing through 6 Ω resistance.



Solution:

1- The effect of 24V source

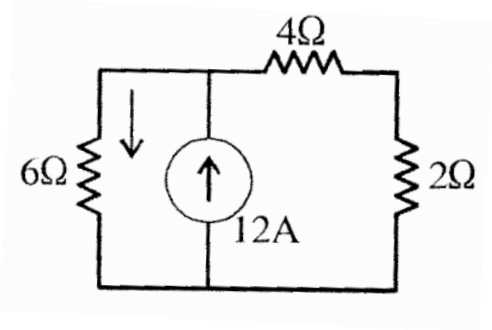


$$R_T = 6 + 4 + 2 = 12\Omega$$

$$I = \frac{24V}{12\Omega} = 2A$$

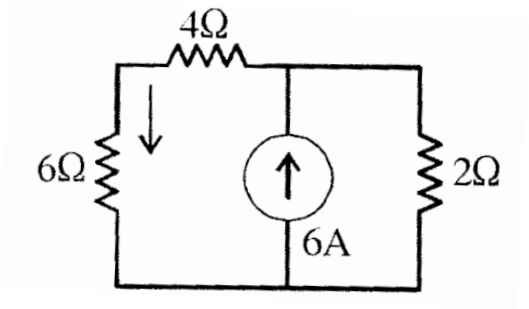
$$I_{6\Omega}{}' = I = 2A \uparrow$$

2- The effect of 12A source



$$I_{6\Omega}{}'' = \frac{I}{2} = \frac{12}{2} = 6A \downarrow$$

3- The effect of 6A source



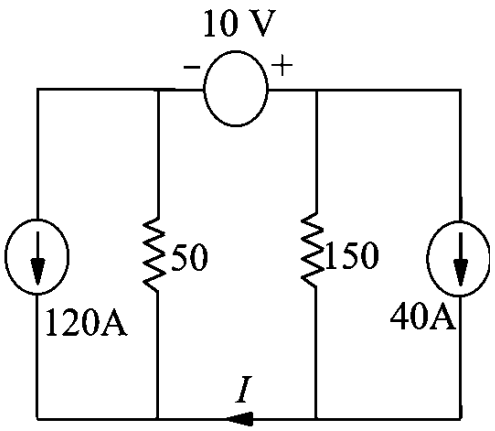
$$I_{6\Omega}{}''' = \frac{I \times 2}{2+4+6} = \frac{6 \times 2}{12} = 1A \downarrow$$

Then the total current is

$$I_{6\Omega} = -I'_{6\Omega} + I''_{6\Omega} + I'''_{6\Omega}$$

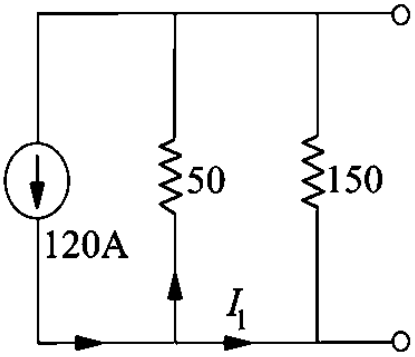
$$I_{6\Omega} = -2 + 6 + 1 = 5A$$

Example 3: Using superposition theorem Find the value and direction of current I.



Sol:

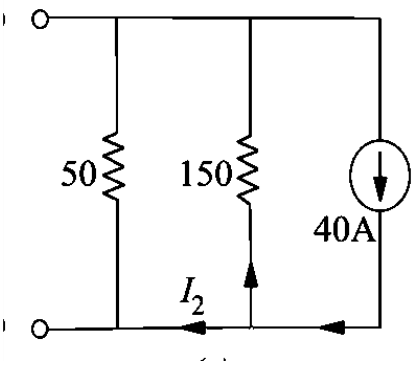
1- The effect of 120 A source



$$I_1 = 120 * \frac{50}{150 + 50}$$

$$I_1 = 30\ A$$

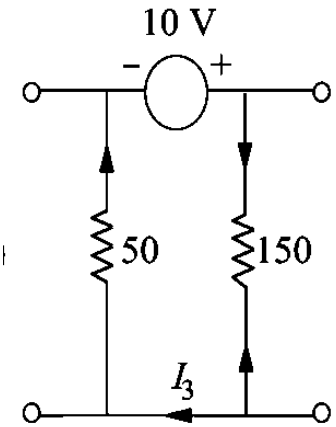
2- The effect of 40 A source



$$I_2 = 40 * \frac{150}{150 + 50}$$

$$I_2 = 30\ A$$

3- The effect of 10V source



$$I_3 = \frac{10}{150 + 50}$$

$$I_3 = 0.05\ A$$

The total current with effect of direction

$$I = -I_1 + I_2 + I_3 = 0.05\ A$$