

10-Series – Parallel Circuits

Introduction

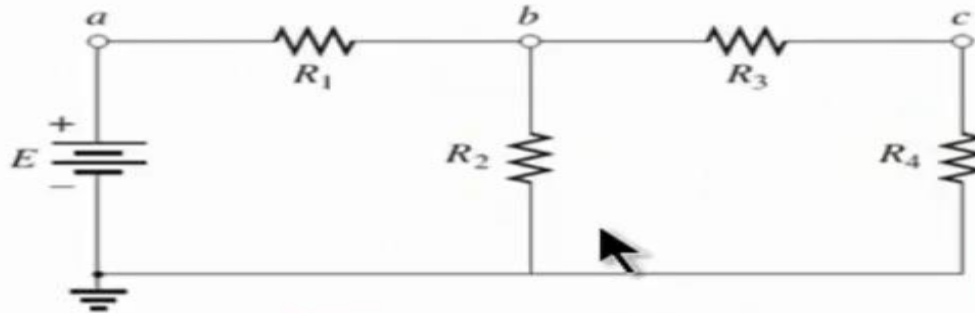
Introduction

INTRODUCTION

A series-parallel configuration is one that is formed by a combination of series and parallel elements.

A complex configuration is one in which none of the elements are in series or parallel.

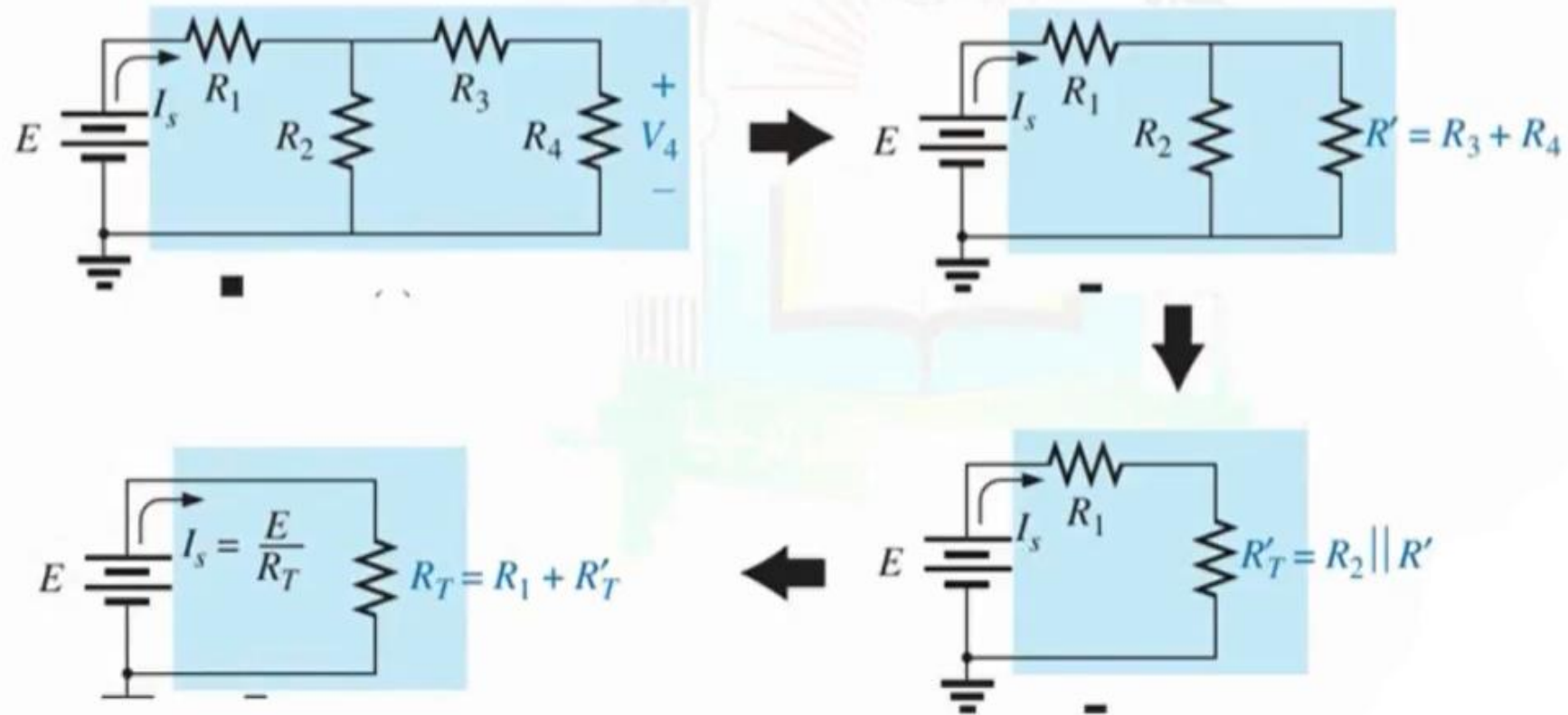
Series-Parallel Circuits



Series-parallel dc network

Example

Series-Parallel Circuits



Examples

EXAMPLE

Find current I_3 for the series parallel network in Fig.

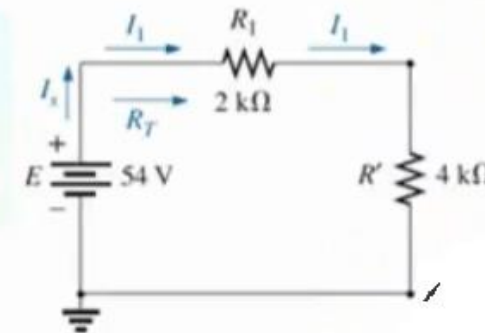
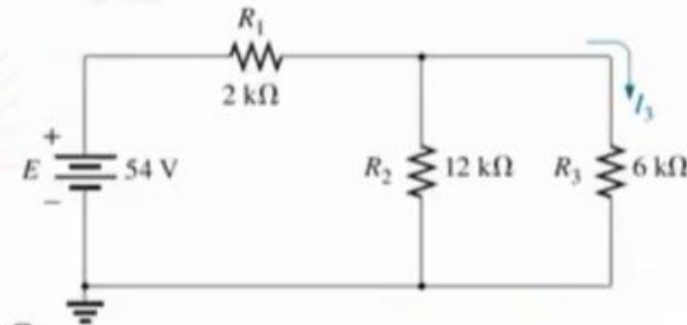
Solution:

$$R' = R_2 \parallel R_3 = \frac{R_2 R_3}{R_2 + R_3} = \frac{(12 \text{ k}\Omega)(6 \text{ k}\Omega)}{12 \text{ k}\Omega + 6 \text{ k}\Omega} = 4 \text{ k}\Omega$$

$$R_T = R_1 + R' = 2 \text{ k}\Omega + 4 \text{ k}\Omega = 6 \text{ k}\Omega$$

$$I_s = \frac{E}{R_T} = \frac{54 \text{ V}}{6 \text{ k}\Omega} = 9 \text{ mA}$$

$$I_1 = I_s = 9 \text{ mA}$$

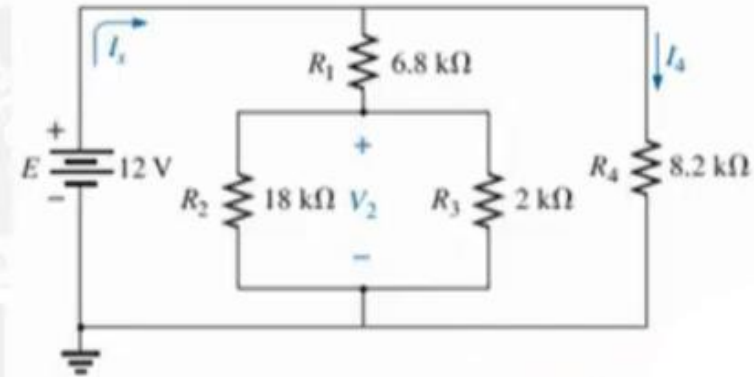


Example

EXAMPLE

For the network in Figure shown:

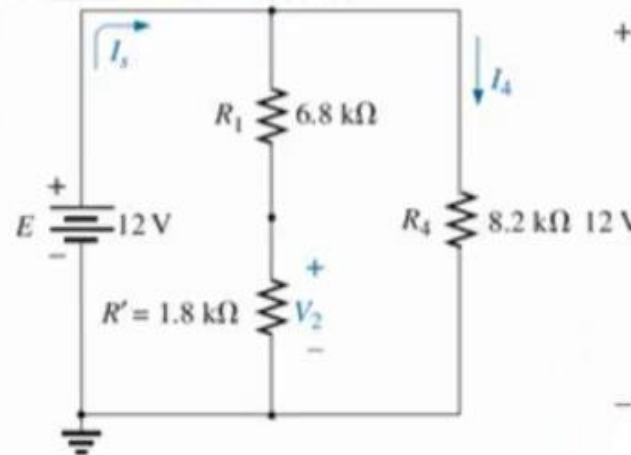
- Determine currents I_4 and I_s and voltage V_2 .
- Insert the meters to measure current I_4 and voltage V_2 .



Solution:

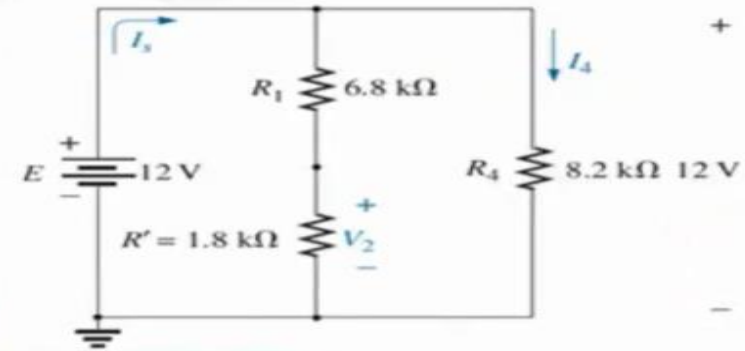
a.

$$R' = R_2 \parallel R_3 = \frac{R_2 R_3}{R_2 + R_3} = \frac{(18\text{ k}\Omega)(2\text{ k}\Omega)}{18\text{ k}\Omega + 2\text{ k}\Omega} = 1.8\text{ k}\Omega$$

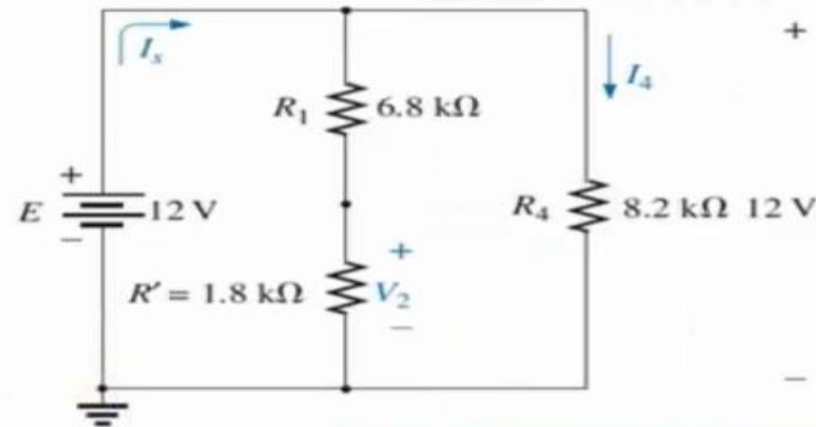


continue

That is, the voltage across the series combination of R_1 and is 12 V and that across resistor R_4 is 12 V. The result is that I_4 can be determined directly using Ohm's law as follows



$$I_4 = \frac{V_4}{R_4} = \frac{E}{R_4} = \frac{12 \text{ V}}{8.2 \text{ k}\Omega} = \mathbf{1.46 \text{ mA}}$$



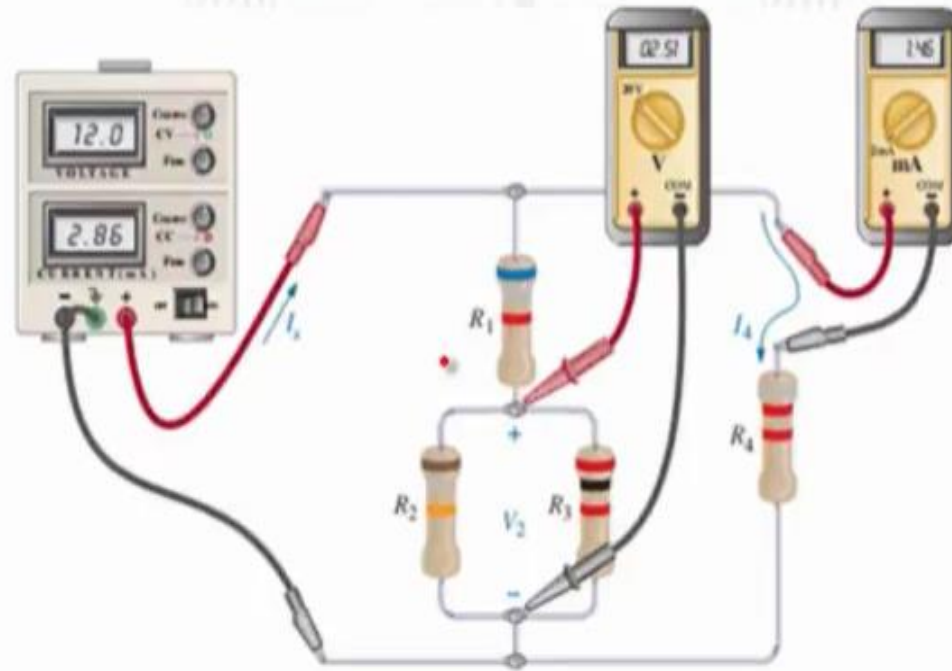
$$V_2 = \left(\frac{R'}{R' + R_1} \right) E = \left(\frac{1.8 \text{ k}\Omega}{1.8 \text{ k}\Omega + 6.8 \text{ k}\Omega} \right) 12 \text{ V} = \mathbf{2.51 \text{ V}}$$

$$I_1 = \frac{E}{R_1 + R'} = \frac{12 \text{ V}}{6.8 \text{ k}\Omega + 1.8 \text{ k}\Omega} = 1.40 \text{ mA}$$

and $I_s = I_1 + I_4 = 1.40 \text{ mA} + 1.46 \text{ mA} = \mathbf{2.86 \text{ mA}}$

Practical connection

The meters have been properly inserted in Fig shown below. Note that the voltmeter is across both resistors since the voltage across parallel elements is the same. In addition, note that the ammeter is in series with resistor R_4 .



Example

EXAMPLE

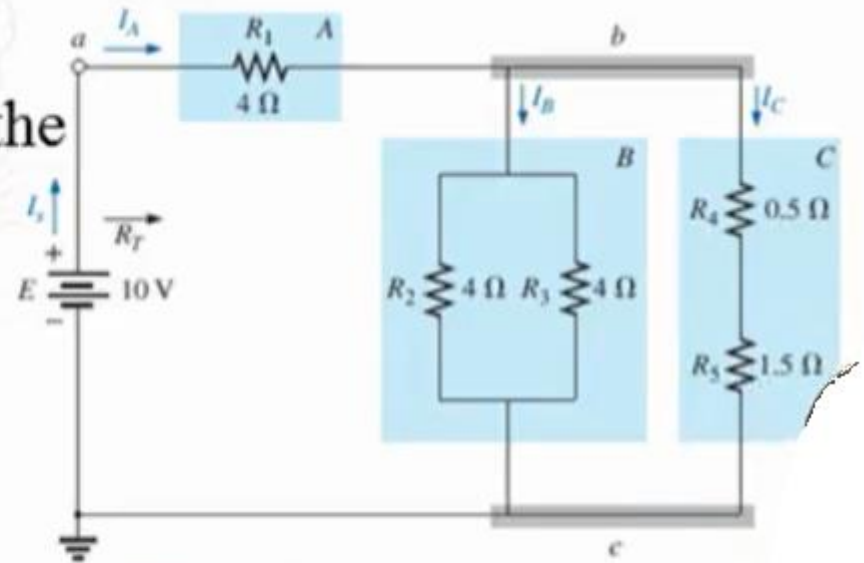
Determine all the currents and voltages of the network in Figure shown.

Solution:

$$A: R_A = 4 \Omega$$

$$B: R_B = R_2 \parallel R_3 = R_{2\parallel 3} = \frac{R}{N} = \frac{4 \Omega}{2} = 2 \Omega$$

$$C: R_C = R_4 + R_5 = R_{4,5} = 0.5 \Omega + 1.5 \Omega = 2 \Omega$$



continue

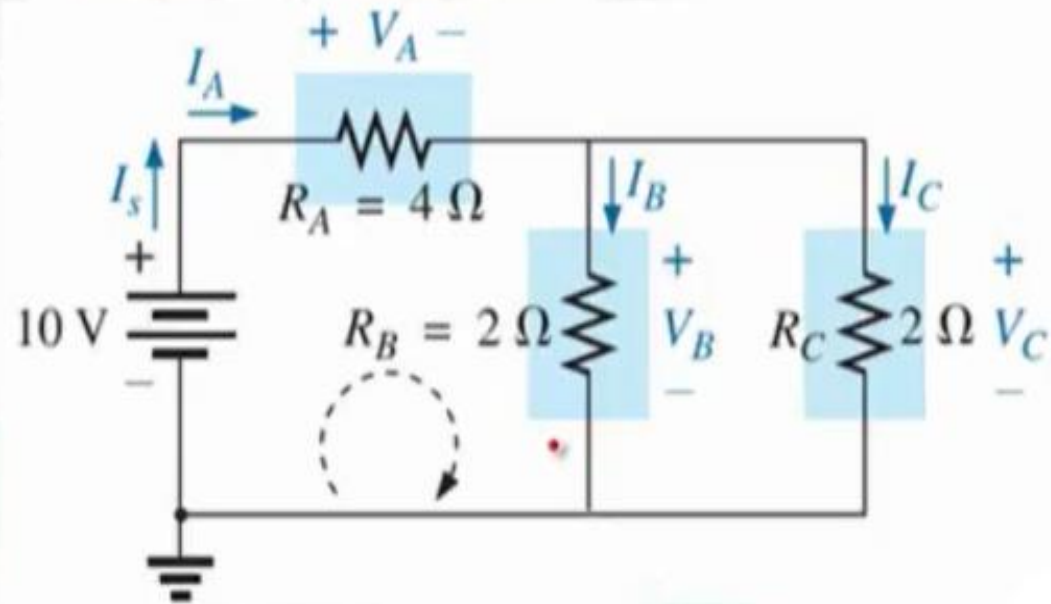
Blocks B and C are still in parallel, and

$$R_{B\parallel C} = \frac{R}{N} = \frac{2\ \Omega}{2} = 1\ \Omega$$

$$\begin{aligned} R_T &= R_A + R_{B\parallel C} \\ &= 4\ \Omega + 1\ \Omega = 5\ \Omega \end{aligned}$$

and $I_s = \frac{E}{R_T} = \frac{10\ \text{V}}{5\ \Omega} = 2\ \text{A}$

$$I_A = I_s = 2\ \text{A}$$



continue

$$I_B = I_C = \frac{I_A}{2} = \frac{I_s}{2} = \frac{2 \text{ A}}{2} = 1 \text{ A}$$

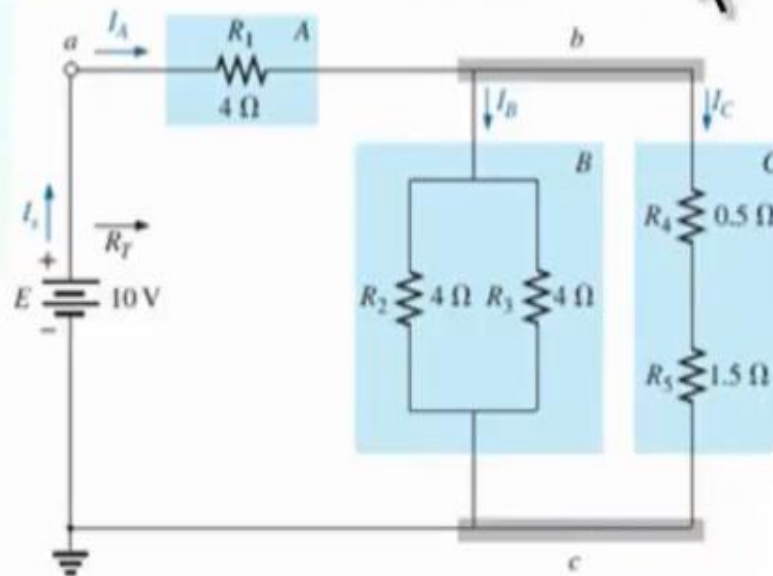
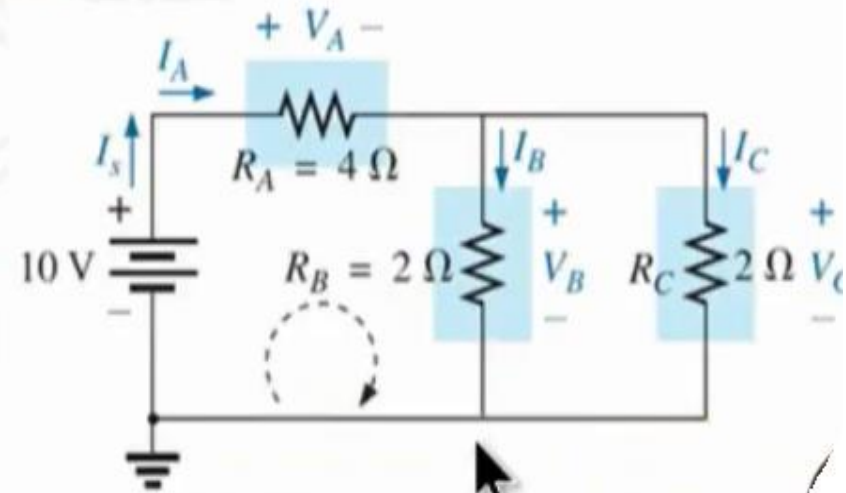
$$I_{R_2} = I_{R_3} = \frac{I_B}{2} = 0.5 \text{ A}$$

The voltages V_A , V_B , and V_C from either figure are :

$$V_A = I_A R_A = (2 \text{ A})(4 \Omega) = 8 \text{ V}$$

$$V_B = I_B R_B = (1 \text{ A})(2 \Omega) = 2 \text{ V}$$

$$V_C = V_B = 2 \text{ V}$$



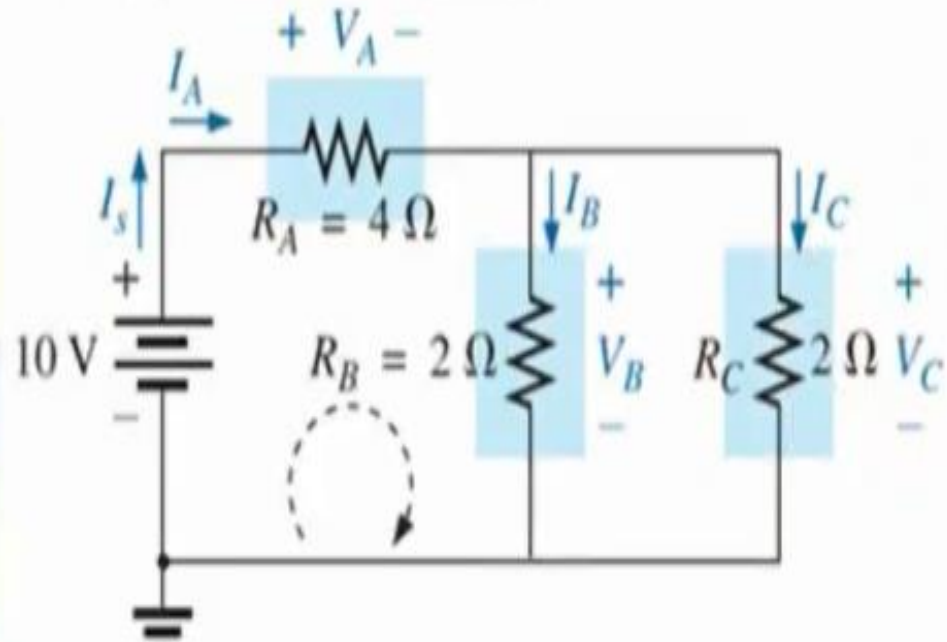
Continue

Applying Kirchhoff's voltage law for the loop indicated in Fig. we obtain

$$\sum_{\text{C}} V = E - V_A - V_B = 0$$

$$E = E_A + V_B = 8 \text{ V} + 2 \text{ V}$$

$$10 \text{ V} = 10 \text{ V} \quad (\text{checks})$$

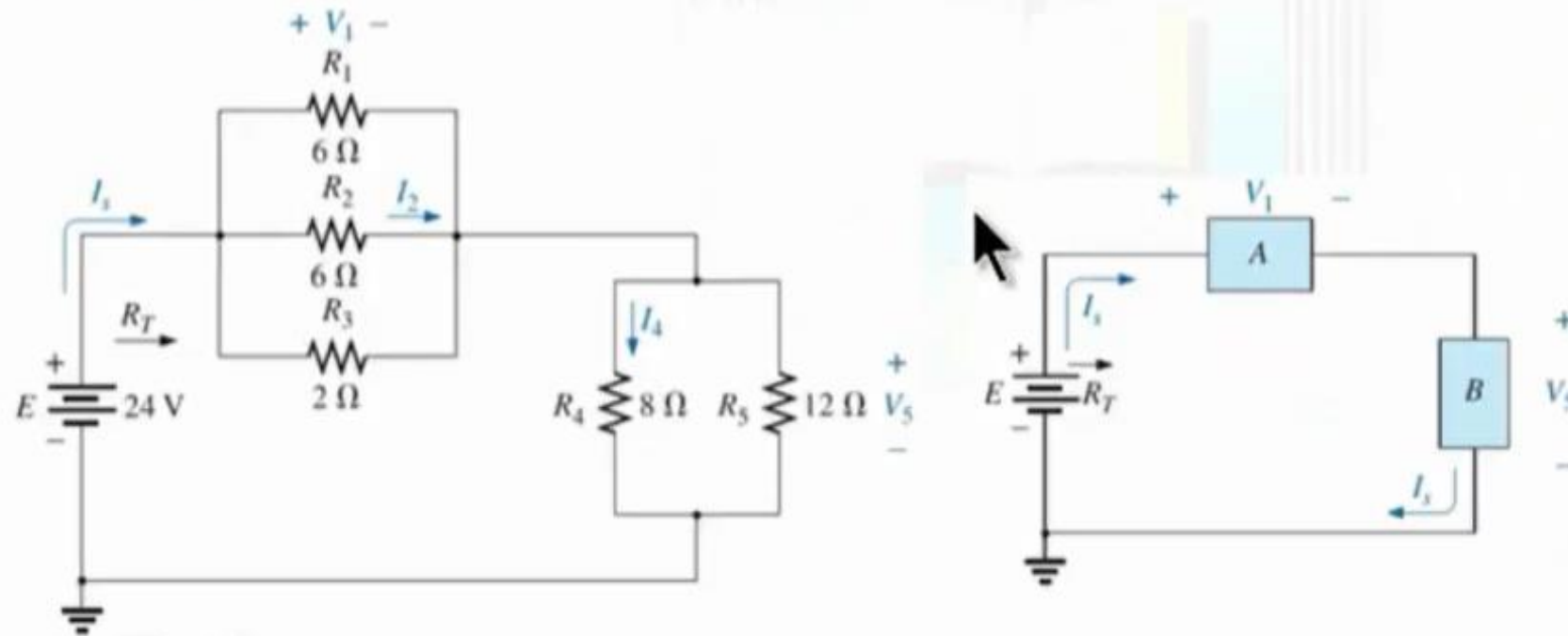


Example

EXAMPLE

Find the indicated currents and voltages for the network in Fig

Solution:



Continue

Solution:

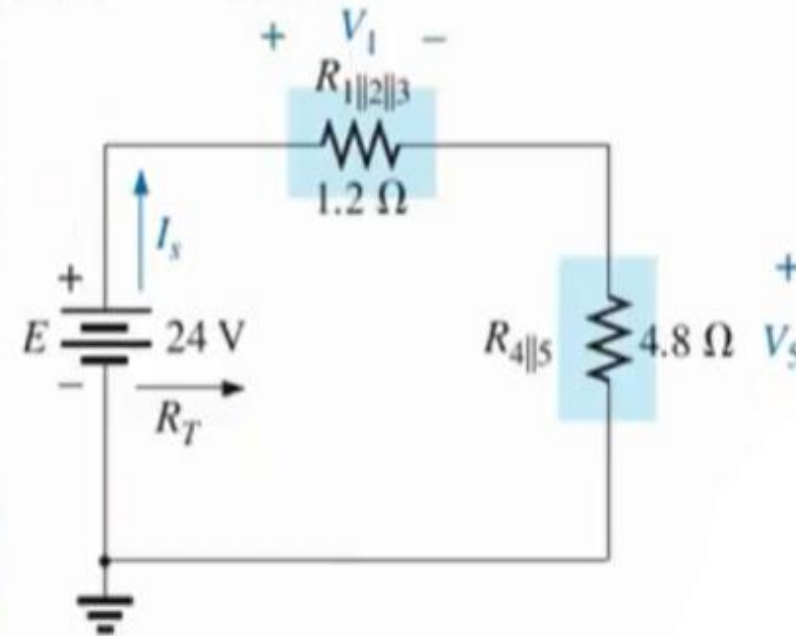
$$R_{1\parallel 2} = \frac{R}{N} = \frac{6\ \Omega}{2} = 3\ \Omega$$

$$R_A = R_{1\parallel 2\parallel 3} = \frac{(3\ \Omega)(2\ \Omega)}{3\ \Omega + 2\ \Omega} = \frac{6\ \Omega}{5} = 1.2\ \Omega$$

$$R_B = R_{4\parallel 5} = \frac{(8\ \Omega)(12\ \Omega)}{8\ \Omega + 12\ \Omega} = \frac{96\ \Omega}{20} = 4.8\ \Omega$$

$$\begin{aligned} R_T &= R_A + R_B = 1.2\ \Omega + 4.8\ \Omega \\ &= 6\ \Omega \end{aligned}$$

$$I_s = \frac{E}{R_T} = \frac{24\ \text{V}}{6\ \Omega} = 4\ \text{A}$$



Continue

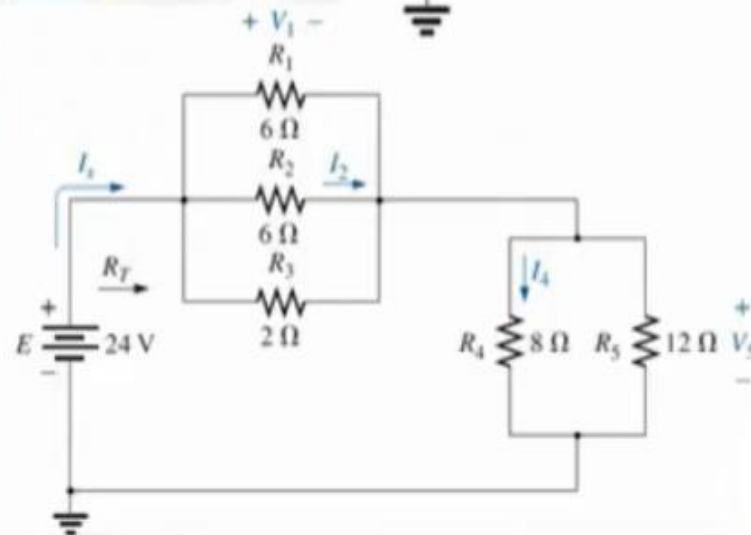
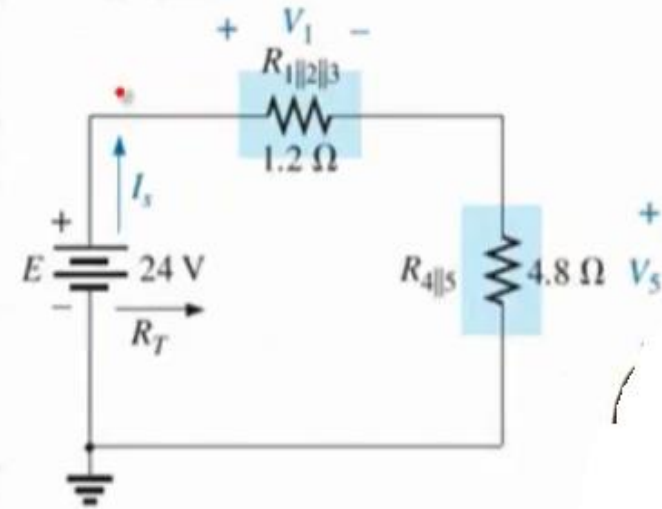
Solution:

$$V_1 = I_s R_{1\parallel 2\parallel 3} = (4 \text{ A})(1.2 \Omega) = \mathbf{4.8 \text{ V}}$$

$$V_5 = I_s R_{4\parallel 5} = (4 \text{ A})(4.8 \Omega) = \mathbf{19.2 \text{ V}}$$

$$I_4 = \frac{V_5}{R_4} = \frac{19.2 \text{ V}}{8 \Omega} = \mathbf{2.4 \text{ A}}$$

$$I_2 = \frac{V_2}{R_2} = \frac{V_1}{R_2} = \frac{4.8 \text{ V}}{6 \Omega} = \mathbf{0.8 \text{ A}}$$



Conclusion

Conclusion

A series-parallel configuration is one that is formed by a combination of series and parallel elements.

A complex configuration is one in which none of the elements are in series or parallel.

we examined the series-parallel combination using the basic laws introduced for series and parallel circuits. There are no new laws or rules to learn simply an approach that permits the analysis of such structures.