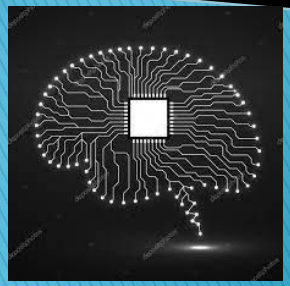
AYDIN
ADNAN MENDERES UNIVERSITY
FACULTY OF ENGINEERING
Department of Electrical and Electronics Engineering

EE201 – Circuit Theory I

Prof. Dr. Yılmaz KALKAN

circuit theory





1. **Basic Concepts (Chapter 1 of Nilsson – Week 1)**

   Introduction, Current and Voltage, Power and Energy

2. **Basic Laws (Chapter 2&3 of Nilsson – Week 2)**

   Voltage and Current Sources, Ohm's Law,

   Kirchhoff's Laws, Resistors in parallel and in series, Voltage and Current Division

3. **Techniques of Circuit Analysis (Chapter 4 of Nilsson – Weeks 3-6)**

   Node Analysis, Node-Voltage Method and Dependent Sources, Mesh Analysis, Mesh-Current Method and Dependent Sources, Source Transformations, Thevenin and Norton Equivalents, Maximum Power Transfer, Superposition Theorem

   MIDTERM (Weeks 7&8)

4. **Operational Amplifier (Chapter 5 of Nilsson – Weeks 9-10)**

   Op-Amp Terminals & Ideal Op-Amp, Basic Op-Amp Circuits, Buffer circuit, Inverting and Non-inverting Amplifiers, Summing Inverter, Difference Amplifier, Cascade Op-Amp Circuits

5. **Capacitors and Inductors (Chapter 6 of Nilsson – Weeks 11)**

   Inductors, Capacitors, Series and Parallel Combinations of them

6. **First Order Circuits (Chapter 7 of Nilsson – Weeks 12 & 13)**

   The Natural Response of an RL & RC Circuits, The Step Response of RL and RC Circuits, A General Solution for Step and Natural Responses, Integrating Amplifier Circuit

7. **Second Order Circuits (Chapter 8 of Nilsson – Weeks 14 & 15)**

   The Natural Response of a Parallel RLC Circuit, The Forms of Natural Response of a Parallel RLC Circuit, The Step Response of a Parallel RLC Circuit, Natural and Step Responses of a Series RLC Circuit

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Summary of Chapter 1

- SI, using prefixes
- Electrical charge, current, voltage, power & energy
- AC/DC

$$p = \frac{dw}{dt}$$

$$i = \frac{dq}{dt}(A) \qquad v = \frac{dw}{dq}(V) \qquad p = v.i(W) \qquad w = \int_{t_o}^{t} p.dt = \int_{t_o}^{t} v.i.dt(J)$$

- **Electric current is always through an element.**
- **Electric voltage is always across the element or between two points. (GROUND)**
- **Passive Sign Convention (PSC)**

If PSC is satisfied, then ⇒ $p = +v.i$ **absorbing power.**

If PSC is not satisfied, then ⇒ $p = -v.i$ **supplying power.**

Chapter 2: Basic Laws

- **Georg Simon Ohm (1787–1854),** a German physicist, in 1826 experimentally determined the most basic law relating voltage and current for a resistor. Ohm's work was initially denied by critics.



- His efforts resulted in his famous law. He was awarded the Copley Medal in 1841 by the Royal Society of London. To honor him, the unit of resistance was named the ohm.

- **Gustav Robert Kirchhoff (1824–1887),** a German physicist, stated two basic laws in 1847 concerning the relationship between the currents and voltages in an electrical network. Kirchhoff's laws, along with Ohm's law, form the basis of circuit theory.



- His collaborative work in spectroscopy with German chemist Robert Bunsen led to the discovery of cesium in 1860 and rubidium in 1861. Kirchhoff was also credited with the Kirchhoff law of radiation. Thus Kirchhoff is famous among engineers, chemists, and physicists.

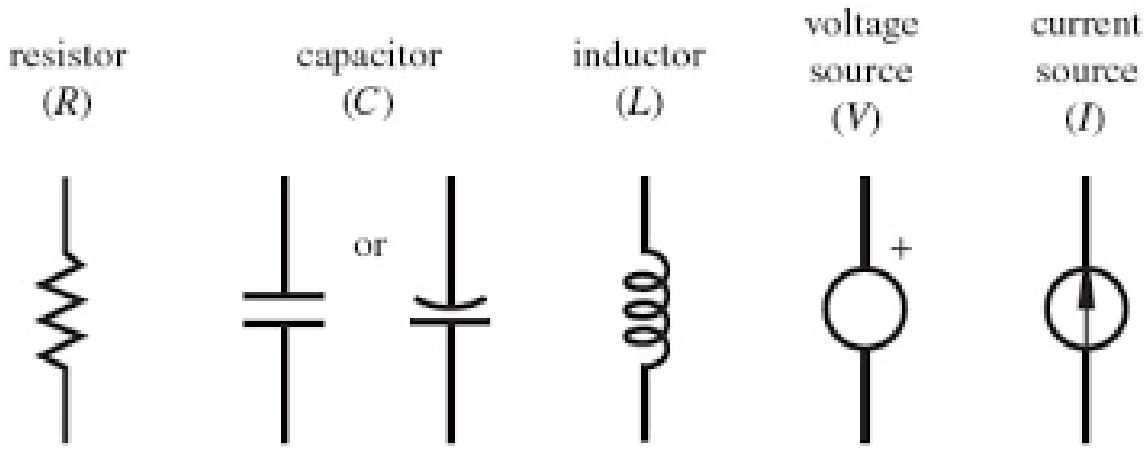
Ch2: Basic Laws

Circuit Elements



There are 5 Ideal Basic Circuit Elements.

- Sources
  - Voltage Sources
  - Current Sources
- Resistors
- Inductors
- Capacitors



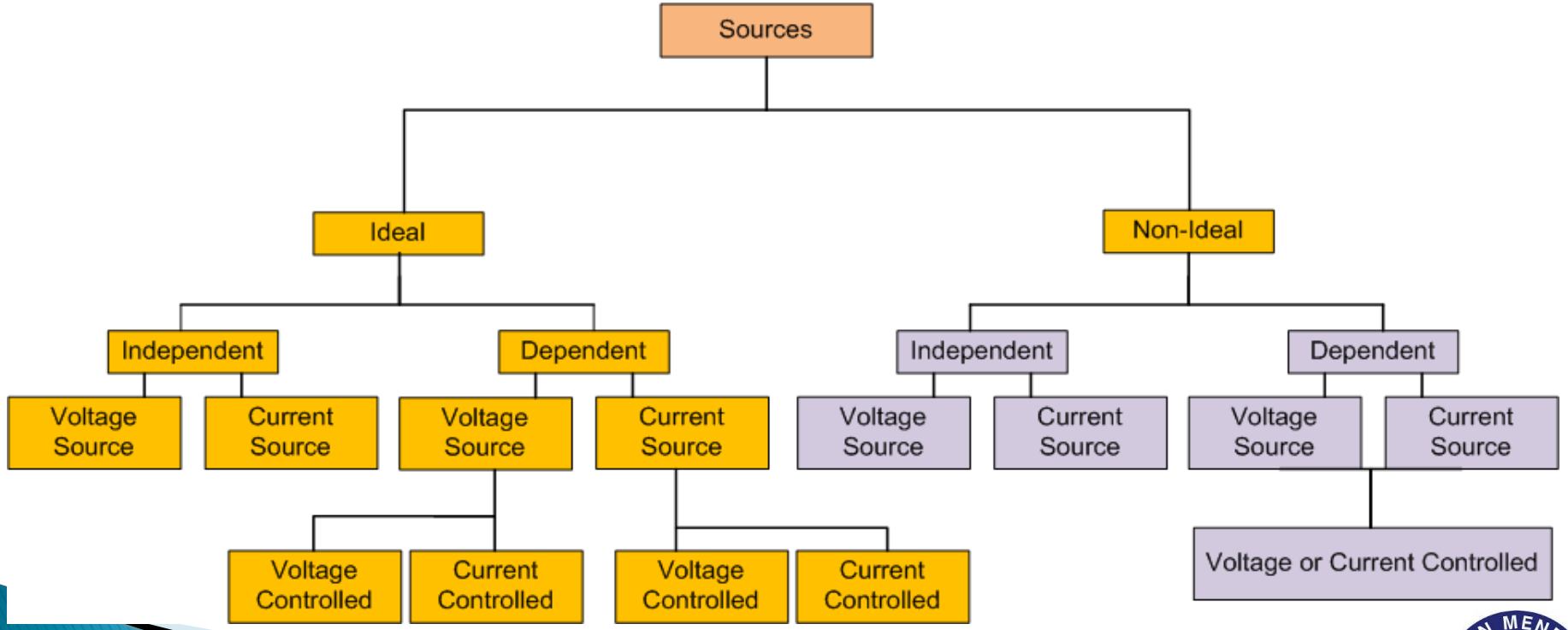
- There are two types of elements found in electric circuits: **passive** elements and **active** elements.

- An **active element** is capable of **generating energy** while a passive element is not.

Ch2: Basic Laws

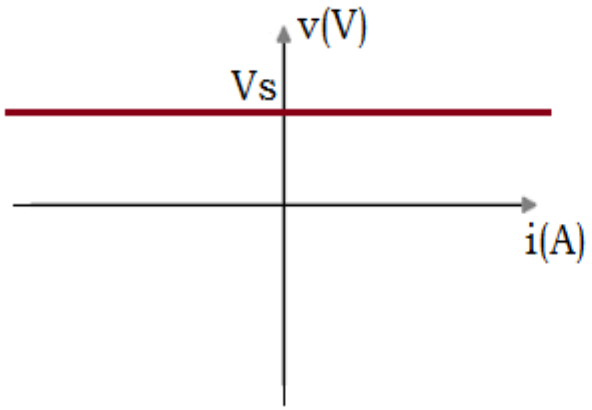
- **Sources**
- The signal and power sources are required to operate electronic circuits are modeled using two elements : Voltage Sources / Current Sources.

- These sources can provide either constant (DC) or time-varying (AC) signals.

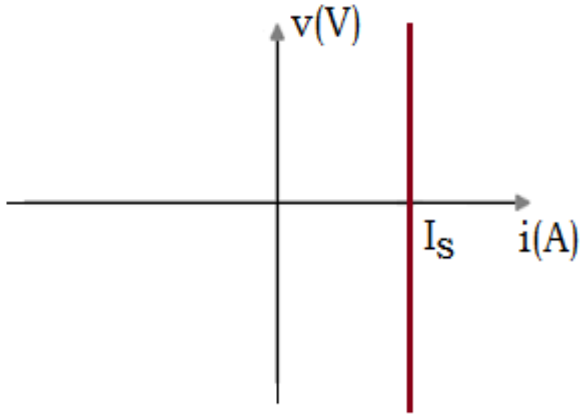


An ideal source could in theory supply an infinite amount of energy!!!!!!

- **Sources**



i-v curve for ideal voltage source



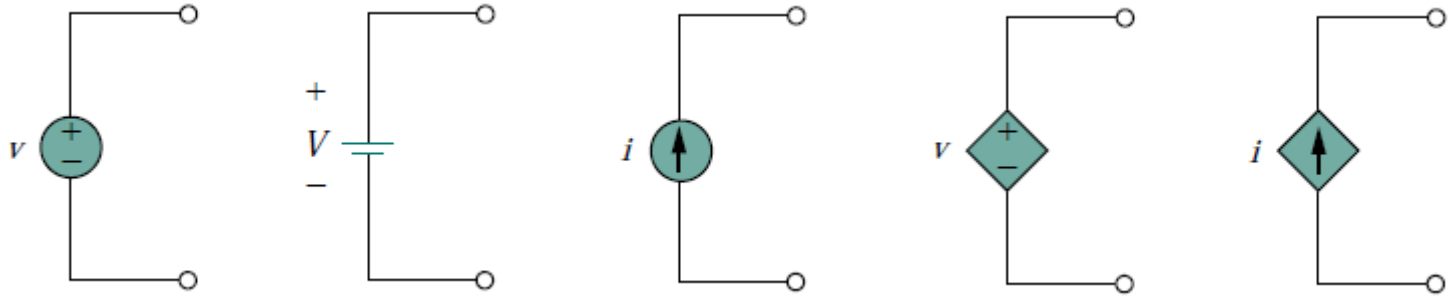
i-v curve for ideal current source

- An **ideal independent source** is an **active** element that provides a specified **voltage** or **current** that is **completely independent** of other circuit variables.

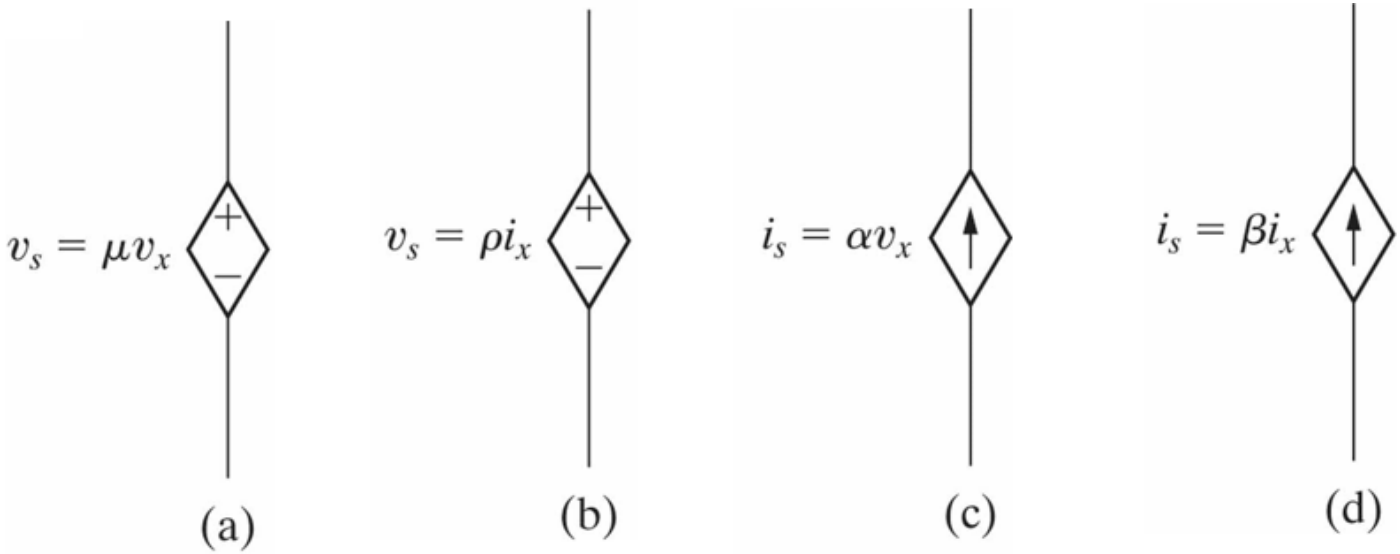
- An **ideal dependent (or controlled) source** is an **active** element in which the source quantity (voltage or current) is **controlled by another voltage or current**.
  - Dependent sources are useful in modeling elements such as transistors, operational amplifiers and integrated circuits.

Ch2: Basic Laws

- **Sources**



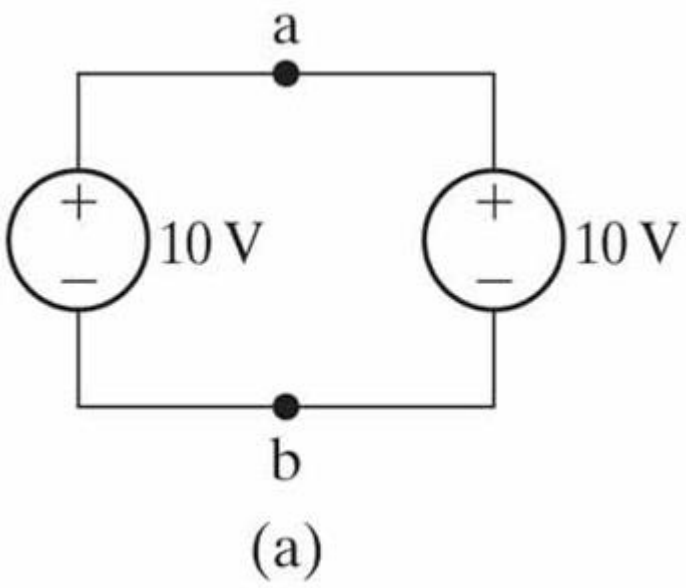
Symbols used to represent dependent and independent voltage and current sources.



Dependent (or controlled) sources.

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- **Sources**
- In the following interconnections of **ideal sources**, which connections are proper?



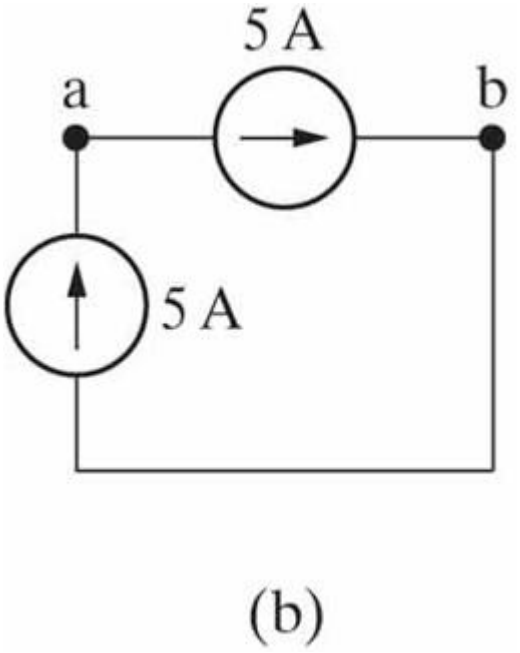
$$V_{ab} = V_{ab} = 10V$$

from both side. Hence, this interconnection is proper.

Interconnections of ideal sources (Example 2.1 from textbook)

Ch2: Basic Laws

- **Sources**
- In the following interconnections of **ideal sources**, which connections are proper?



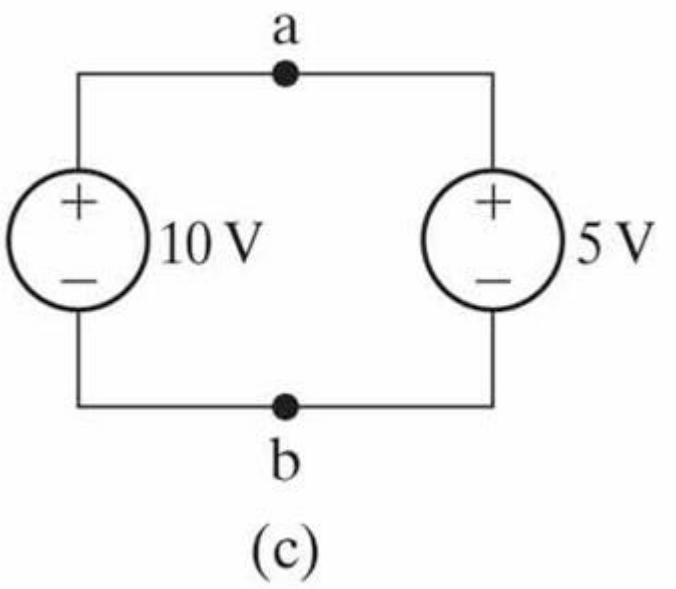
Inside the circuit, we have only one current, I=5A.

This current is proper for both current sources. Hence, this interconnection is proper.

Interconnections of ideal sources (Example 2.1 from textbook)

Ch2: Basic Laws

- **Sources**
- In the following interconnections of **ideal sources**, which connections are proper?



$$from\ left\ V_{ab} = 10V$$

$$from\ right\ V_{ab} = 5V$$

$$V_{ab} = 10\ V\ \&\ V_{ab} = 5V$$

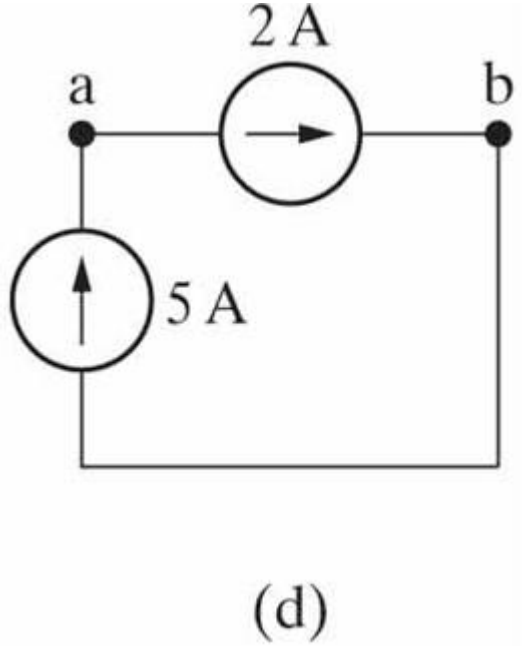
This is not possible. Hence, this interconnection is NOT proper.



Interconnections of ideal sources (Example 2.1 from textbook)

Ch2: Basic Laws

- **Sources**
- In the following interconnections of **ideal sources**, which connections are proper?



$$in\ left\ path\ I = 5A$$

$$in\ upper\ path\ I = 2A$$

$$Due\ to\ serial\ conenction; \mathrm{I} = 5\ \mathrm{A}\ \&\ \mathrm{I} = 2\mathrm{A}$$

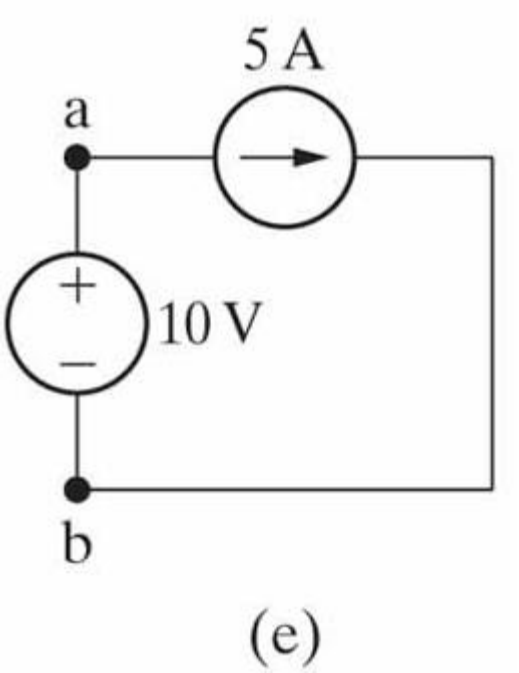
This is not possible. Hence, this interconnection is NOT proper.



Interconnections of ideal sources (Example 2.1 from textbook)

Ch2: Basic Laws

- **Sources**
- In the following interconnections of **ideal sources**, which connections are proper?



An ideal voltage source can give any desired current.

Similarly, an ideal current source can have any desired voltage value.

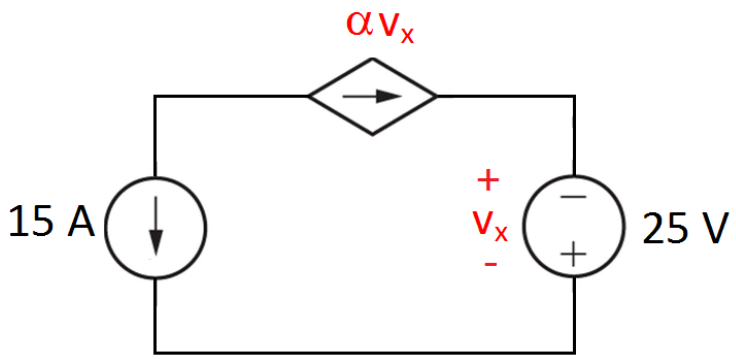
Hence, this interconnection is proper.



Interconnections of ideal sources (Example 2.1 from textbook)

Ch2: Basic Laws

- **Example** (Assesment Problem 2.2 from textbok)



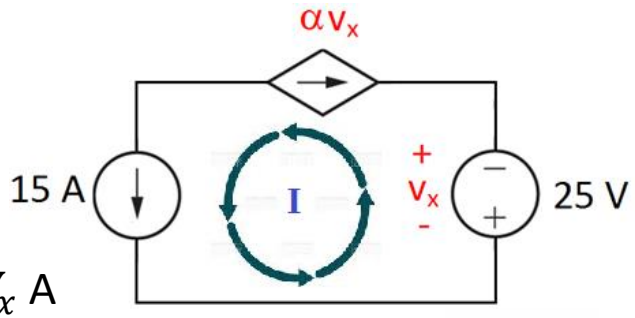
a) What value of alpha is required in order for the interconnection to be valid?

b) For the value of a calculated in part (a), find the power associated with the 25 V source.

Solution:

a) This is a serial connected circuit. We know that serial connected components carry the same amount of current.

Hence, all the components must have same current.



As I & 15A source are in same direction ⇒ $I = 15\ A$

As I & αV_x source are in opposite directions ⇒ $I = -\alpha V_x$ A

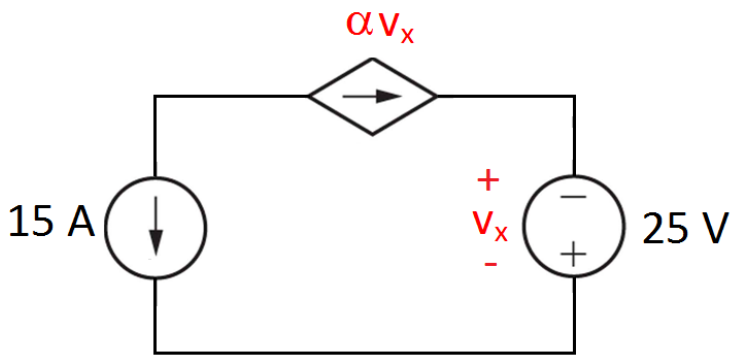
$15 = -\alpha V_x$ A ⇒ $\alpha = {}^{15}/_{25} = 0.6$

$V_x = -25V$

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Ch2: Basic Laws

- **Example** (Assesment Problem 2.2 from textbok)



a) What value of alpha is required in order for the interconnection to be valid?

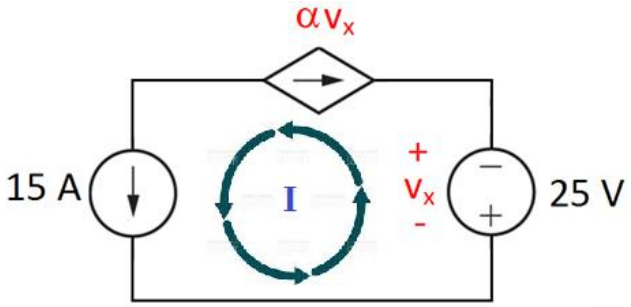
b) For the value of a calculated in part (a), find the power associated with the 25 V source.

Solution:

b) Power of 25V source is

$$P_{25V} = \pm(25V)(I)$$

$$P_{25V} = \pm(25V)(15) = \pm 375W$$



What is the polarity of power?

As PSC is satisfied, the polarity of power is positive

$P_{25V} = 375W$ Absorbed power !!

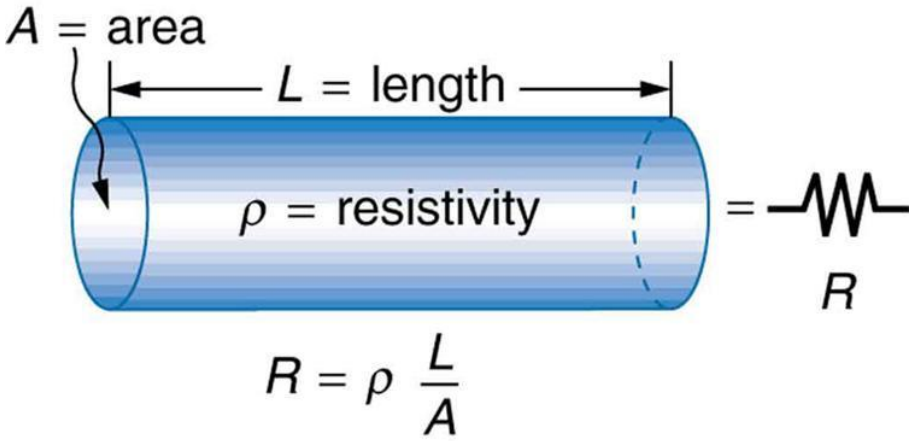
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Ch2: Basic Laws – Ohm's Law



- **OHM's LAW**

- Materials in general have a characteristic behavior of resisting the flow of electric charge. This physical property, or ability to resist current, is known as ***resistance*** *and is represented by the symbol* ***R***. It is measured in ohms and Greek letter omega (**Ω**) is the symbol for ohm.
- *The resistance* of any material with a uniform cross-sectional area *A can be given as:*



$$R = \rho \frac{L}{A}$$

$$R = \rho \frac{\ell}{A}$$

where **ρ** *is known as the* ***resistivity*** *of the material in ohm-meters*

Ch2: Basic Laws – Ohm's Law

Material	ρ (Ω – m) resistivity at 20° C
Silver	1.59×10^{-8}
Copper	1.68×10^{-8}
Gold	2.24×10^{-8}
Aluminium	2.82×10^{-8}
Calcium	3.36×10^{-8}
Tungsten	5.60×10^{-8}
Zinc	5.90×10^{-8}
Nickel	6.99×10^{-8}
Iron	1.00×10^{-7}
Lead	2.20×10^{-7}

Material	ρ (Ω – m) resistivity at 20° C
Nichrome	1.10×10^{-6}
Carbon (Graphite)	2.50×10^{-6}
Germanium	4.60×10^{-1}
Drinking water	2.00×10^{-1}
Silicon	6.40×10^{2}
Wet wood	1.00×10^{3}
Glass	10.0×10^{10}
Rubber	1.00×10^{13}
Air	1.30×10^{16}

$$R = \rho \frac{\ell}{A}$$

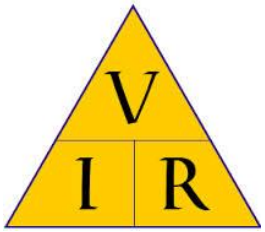
- The circuit element used to model this behavior is the **resistor.**

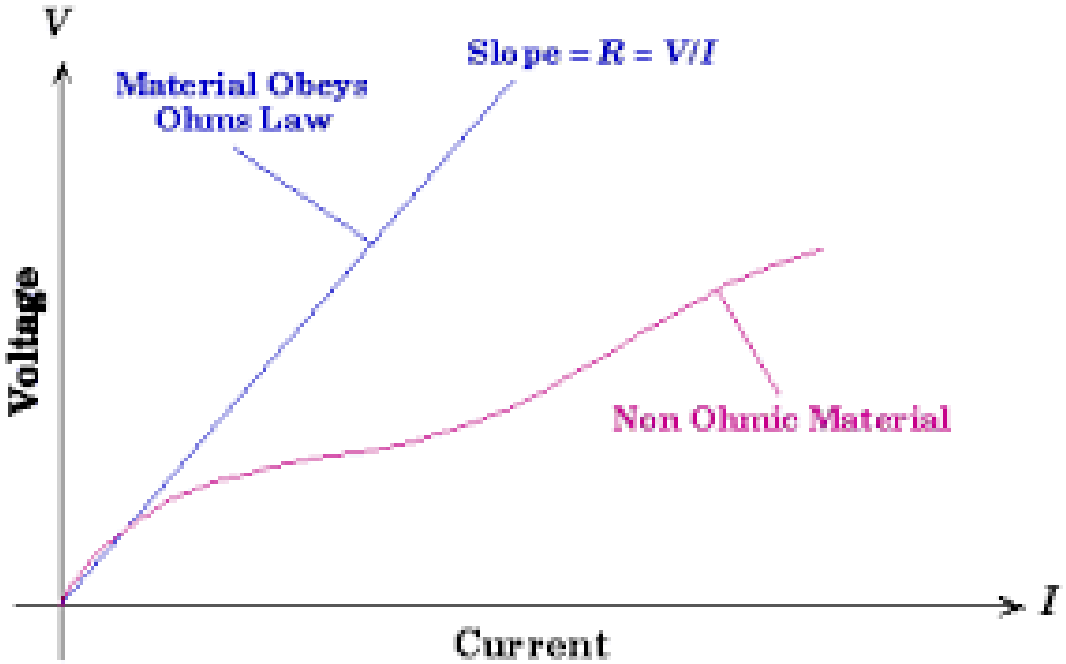


Ch2: Basic Laws – Ohm's Law

- **Ohm's law** states that the voltage ***v*** *across a resistor is directly proportional* to the current ***i*** *flowing through the resistor.*

$$v = i.R$$

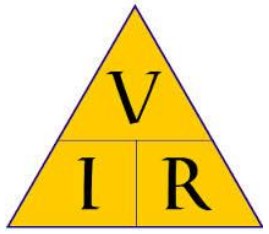


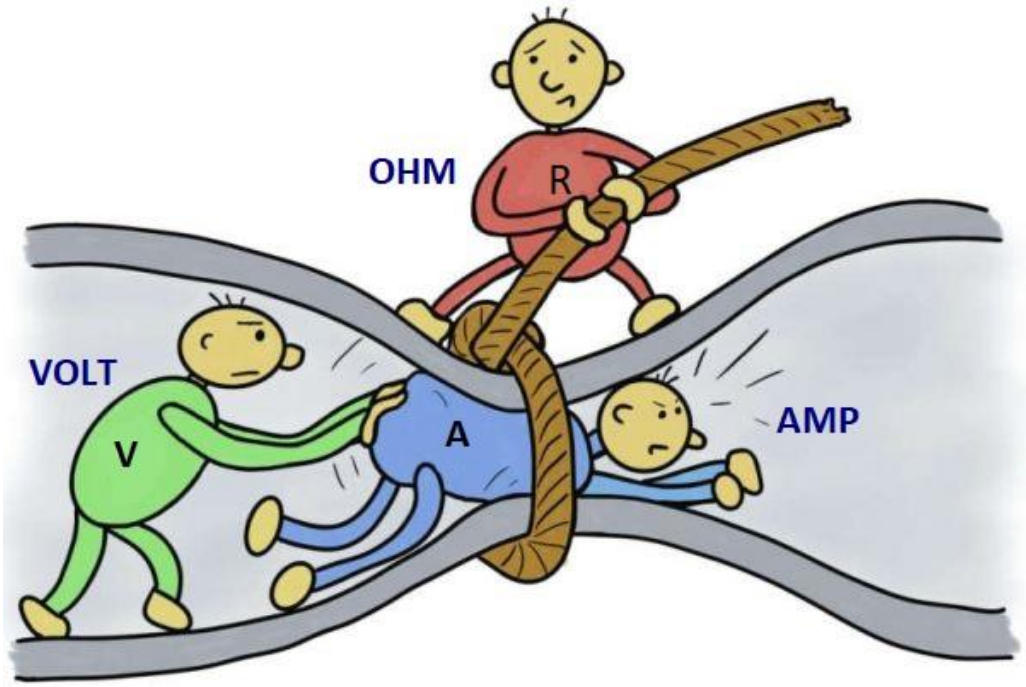


Ch2: Basic Laws – Ohm's Law

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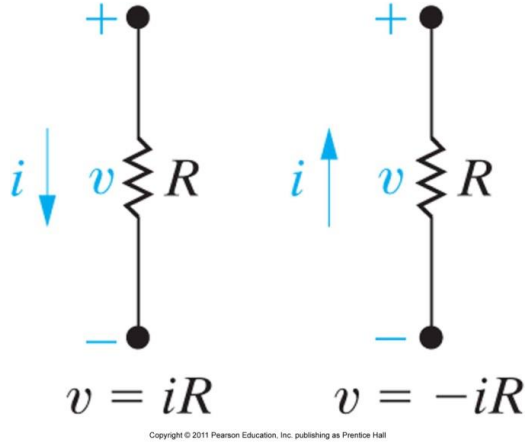




Ch2: Basic Laws – Ohm's Law

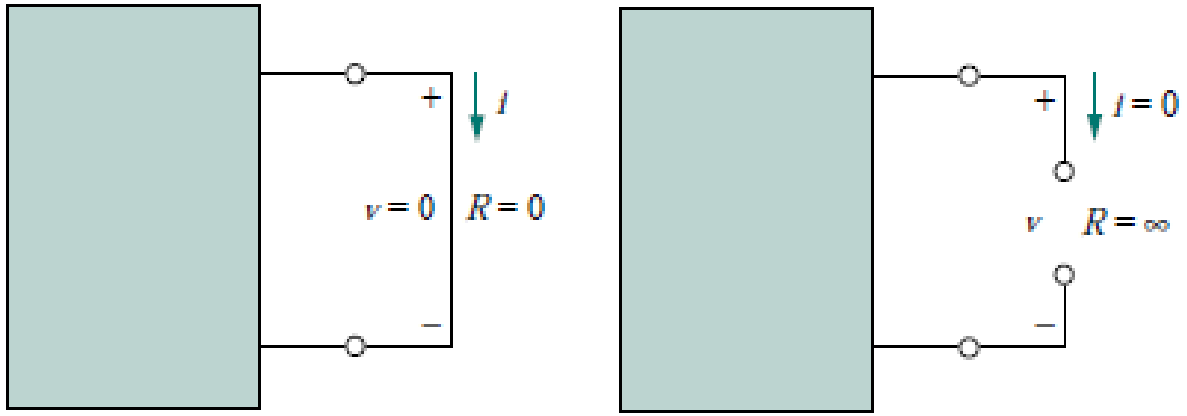
- The direction of current i and the polarity of voltage v must conform with the **PSC**. This implies that current flows from a higher potential to a lower potential in order for v = iR.

$$0 \leq R \leq \infty$$



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- An element with ***R = 0*** *is called a* ***short circuit.***
- An element with ***R =∞****is known as an* ***open circuit.***



Ch2: Basic Laws – Ohm's Law

- The **power** dissipated by a resistor can be expressed in terms of *R*

$$P = v.i = v.\frac{v}{R} = \frac{v^2}{R} \quad \Rightarrow \quad \boxed{P = \frac{v^2}{R}}$$

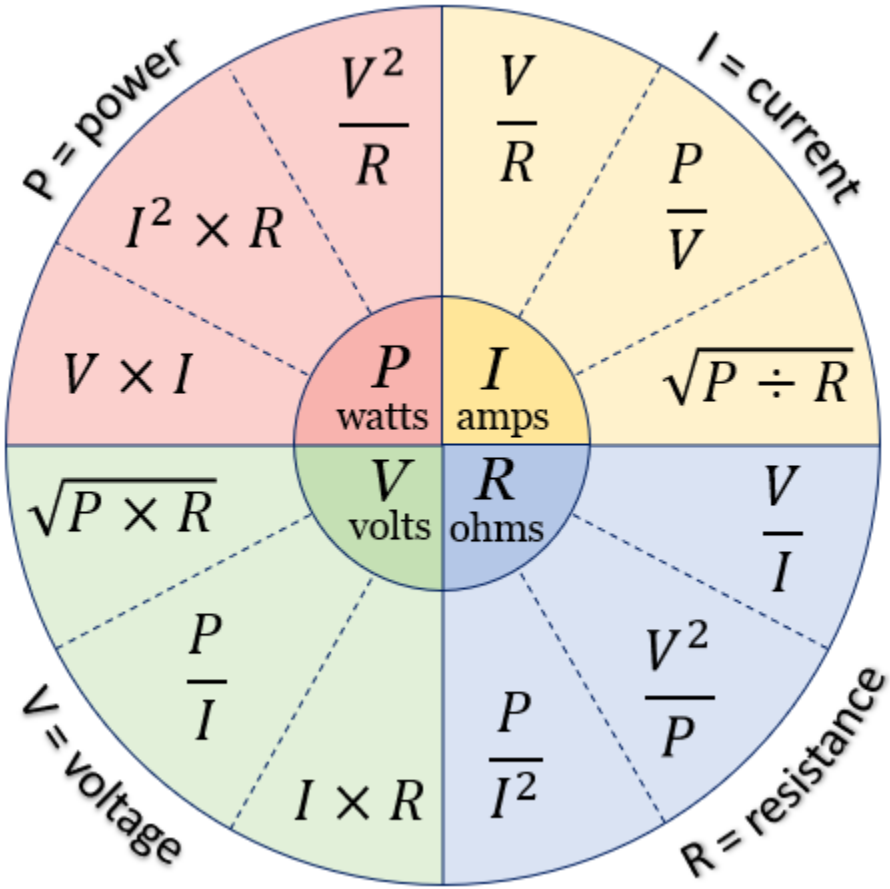
$$P = v.i = i.R.i = i^2 R \quad \Rightarrow \quad \boxed{P = i^2 R}$$

- A useful quantity in circuit analysis is the reciprocal of resistance *R, known as* ***conductance*** *and denoted by* ***G.***

- Conductance is the ability of an element to conduct electric current; it is measured in mhos *(℧) or siemens (**S**).*

$$\boxed{G = \frac{1}{R}}$$

Ch2: Basic Laws – Ohm's Law

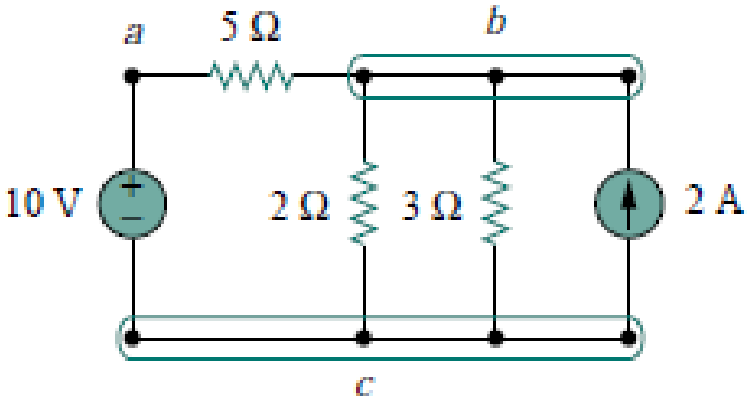


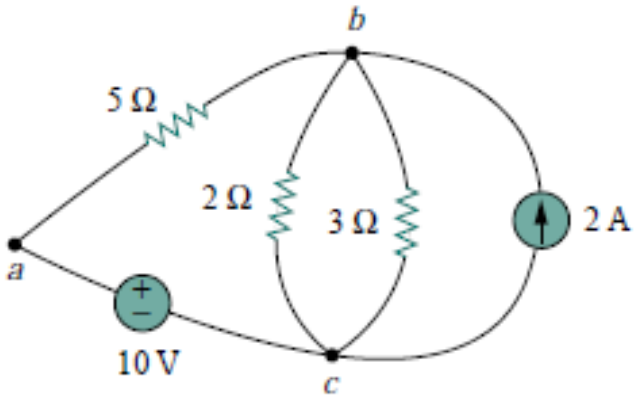
Ch2: Basic Laws – Nodes, Branches, Loops

- Since the elements of an electric circuit can be interconnected in several ways, we need to understand some basic concepts of **network topology**.

- A **branch** represents a **single element** such as a voltage source or a resistor. In other words, a branch represents any two-terminal element.

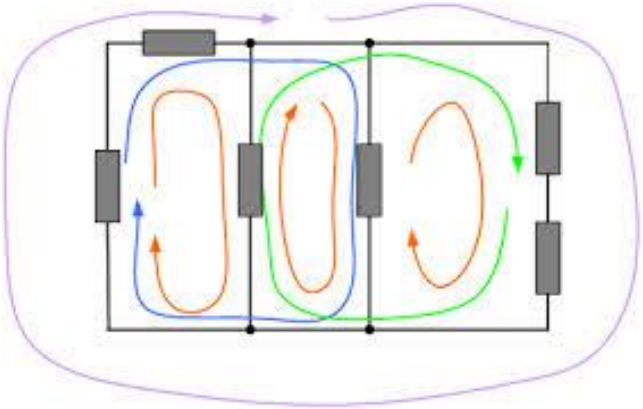
- A **node** is the **point of connection** between two or more branches. A node is usually indicated by a dot in a circuit. If a short circuit (a connecting wire) connects two nodes, the two nodes constitute a **single node**.





Ch2: Basic Laws – Nodes, Branches, Loops

- A **loop** is any **closed path** in a circuit. A loop is a closed path formed by starting at a node, passing through a set of nodes, and returning to the starting node without passing through any node more than once



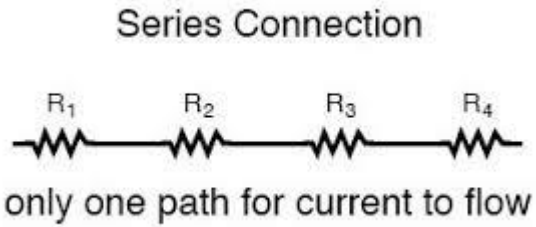
- A loop is said to be **independent** if it contains at least one branch which is not a part of any other independent loop. Independent loops or paths result in independent sets of equations.

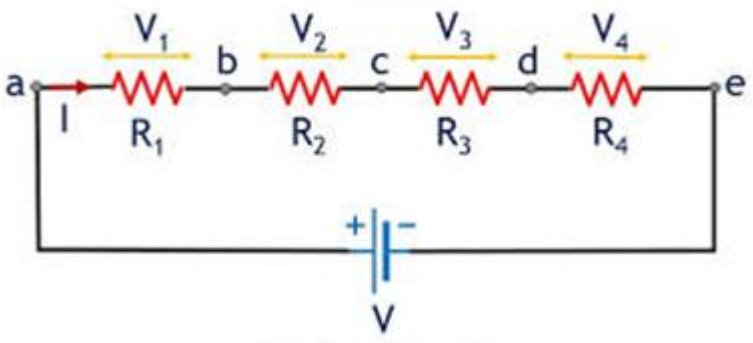
- A network with **b** branches, **n** nodes, and **l** independent loops will satisfy the fundamental theorem of network topology:

$$b = l + n - 1$$

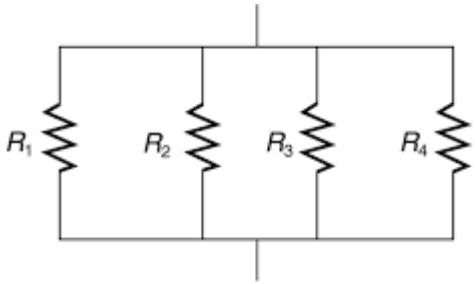
Ch2: Basic Laws – Nodes, Branches, Loops

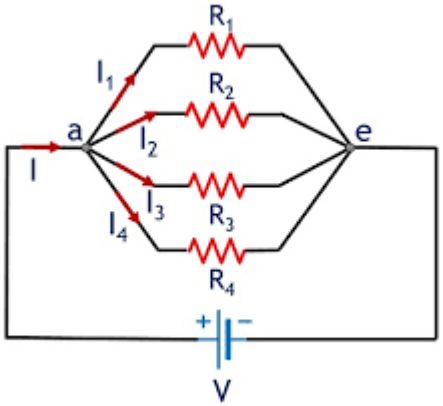
❑ Two or more elements are in **series** if they are cascaded or connected sequentially and consequently **carry the same current**.





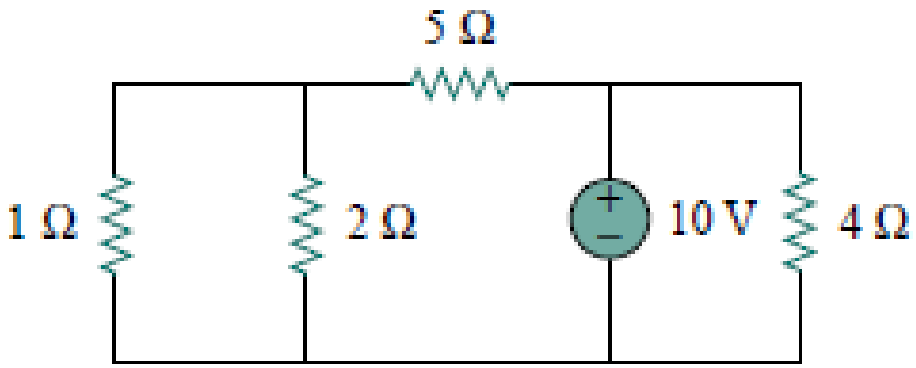
❑ Two or more elements are in **parallel** if they are connected to the same two nodes and consequently **have the same voltage across** them.





Ch2: Basic Laws – Nodes, Branches, Loops

- **Examples**



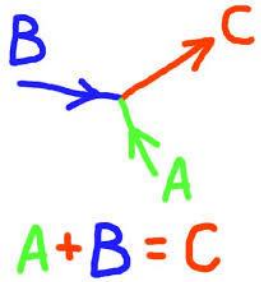
- How many branches and nodes does the circuit in figure above have? Identify the elements that are in series and in parallel.

- **5 branches**
- **3 nodes**
- **6 loops**
- **3 independent lopps**

- **1Ω and 2Ω resistors are in parallel**
- **4Ω resistor and 10V source are also in parallel**
- **No serial connection!**

$$b = l + n - 1 \Rightarrow 5 = 3 + 3 - 1 \Rightarrow 5 = 5$$

Ch2: Basic Laws – Kirchhoff's Laws



- Ohm's law by itself is not sufficient to analyze circuits.
- However, when it is coupled with **Kirchhoff's two laws**, we have a sufficient, powerful set of tools for **analyzing** a large variety of electric circuits.
- Kirchhoff's laws were first introduced in 1847 by the German physicist Gustav Robert Kirchhoff (1824–1887). These laws are formally known as **Kirchhoff's current law** (**KCL**) and **Kirchhoff's voltage law** (**KVL**).
- Kirchhoff's first law is based on the law of conservation of charge, which requires that the algebraic sum of charges within a system cannot change.
- **KCL :** The algebraic sum of all the currents at any node in a circuit equals zero.

$$\sum_{n=1}^{N} i_n = 0$$

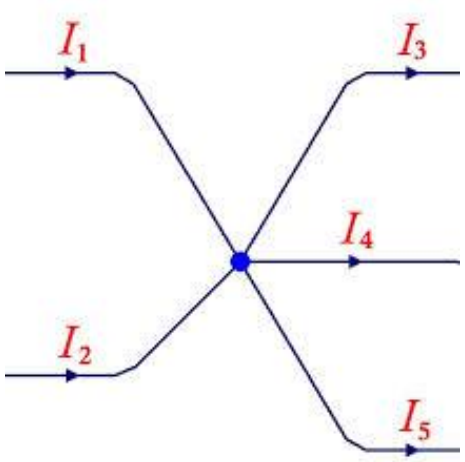
N : total # of currents at that node
n : current number

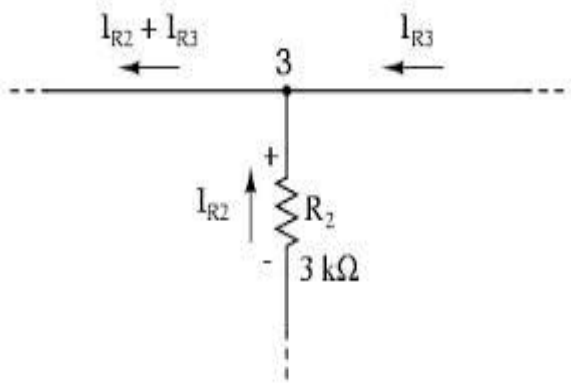
Ch2: Basic Laws – Kirchhoff's Laws – KCL

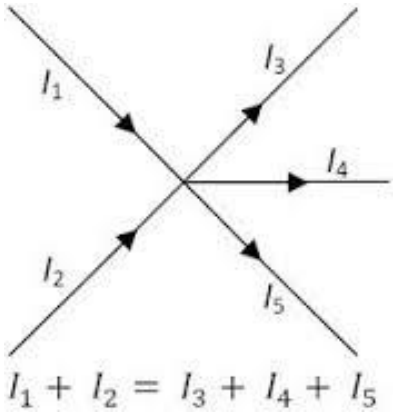
- **Kirchhoff's Current Law (KCL)**

$$\sum_{n=1}^{N} i_n = 0$$

- In **any electric circuits, for any node**, the sum of the currents entering a node is equal to the sum of the currents leaving from that node.

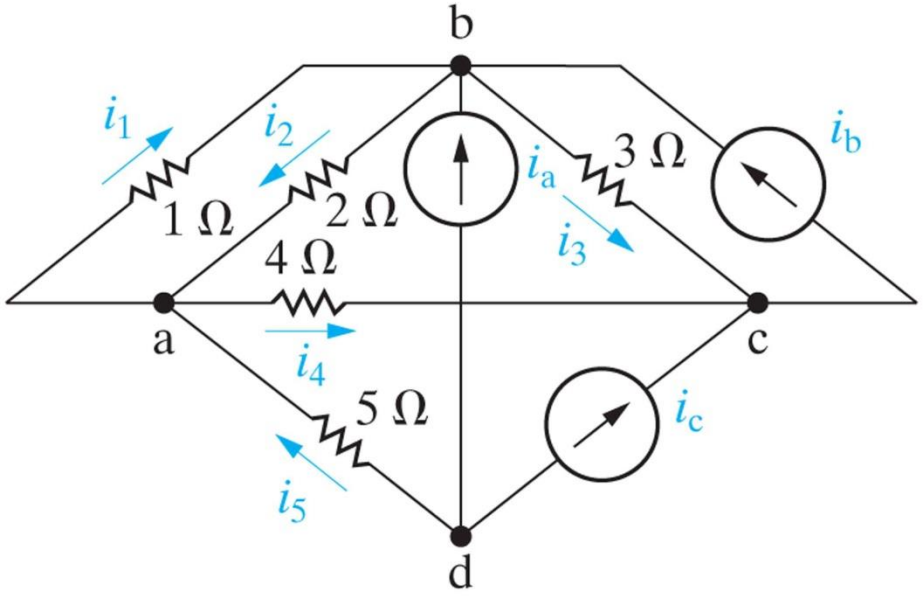






Ch2: Basic Laws – Kirchhoff's Laws – KCL

- **Example** (Example 2.6 from textbok)



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KCL @ node a → $i_1 + i_4 = i_2 + i_5$

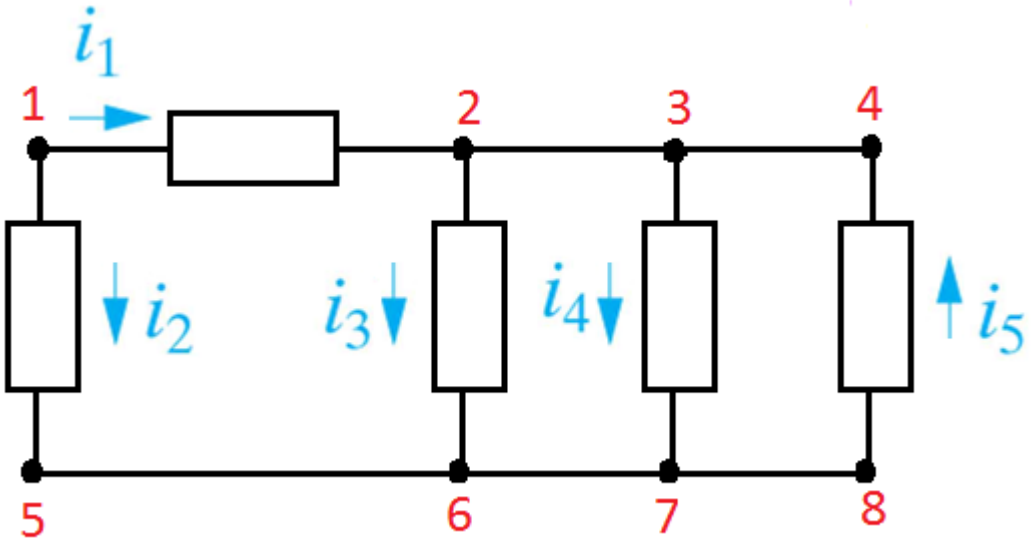
KCL @ node b → $i_1 + i_a + i_b = i_2 + i_3$

KCL @ node c → $i_3 + i_4 + i_c = i_b$

KCL @ node d → $i_5 + i_a + i_c = 0$

Ch2: Basic Laws – Kirchhoff's Laws – KCL

- **Example**



$$i_1 = 4A$$
$$i_3 = 1A$$
$$i_4 = 2A$$
$$i_2 \ \& \ i_5 = ?$$

$$for\ node\ 1 \rightarrow \ i_1 + i_2 = 0 \ \rightarrow 4A + i_2 = 0 \ \rightarrow \boxed{i_2 = -4A}$$

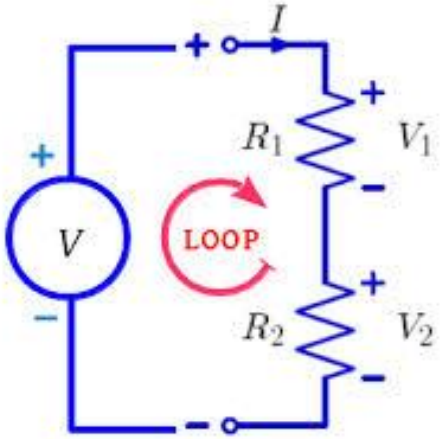
$$for\ node\ 2,3,4 \rightarrow \ i_1 + i_5 = i_3 + i_4 \ \rightarrow 4A + i_5 = 1A + 2A \ \rightarrow \boxed{i_5 = -1A}$$

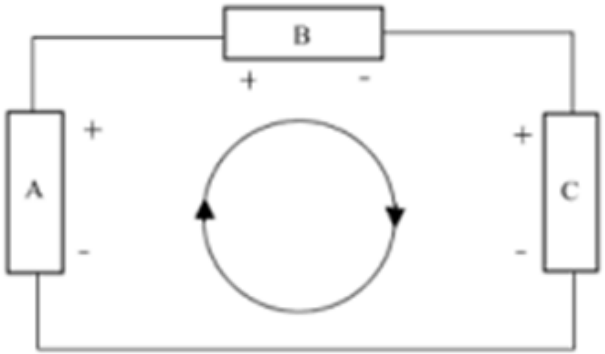
Ch2: Basic Laws – Kirchhoff's Laws – KVL

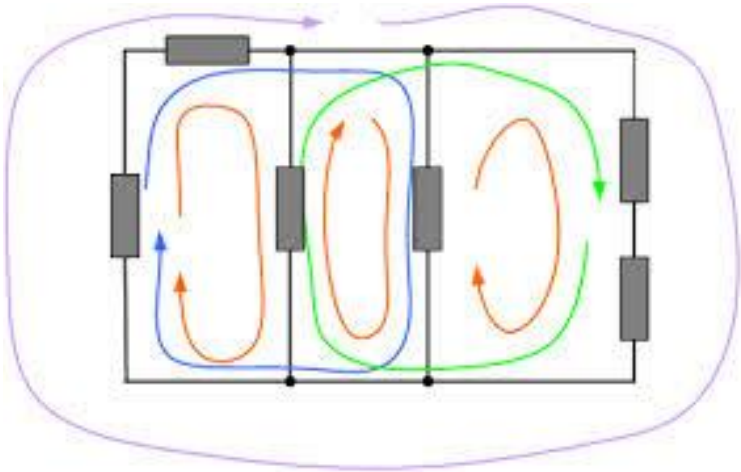
- **Kirchhoff's Voltage Law** (**KVL**) : The algebraic sum of all the voltages around any closed path in a circuit equals zero.

$$\sum_{m=1}^{M} v_m = 0$$

M : total # of branches at that loop
m : branch (voltage) number

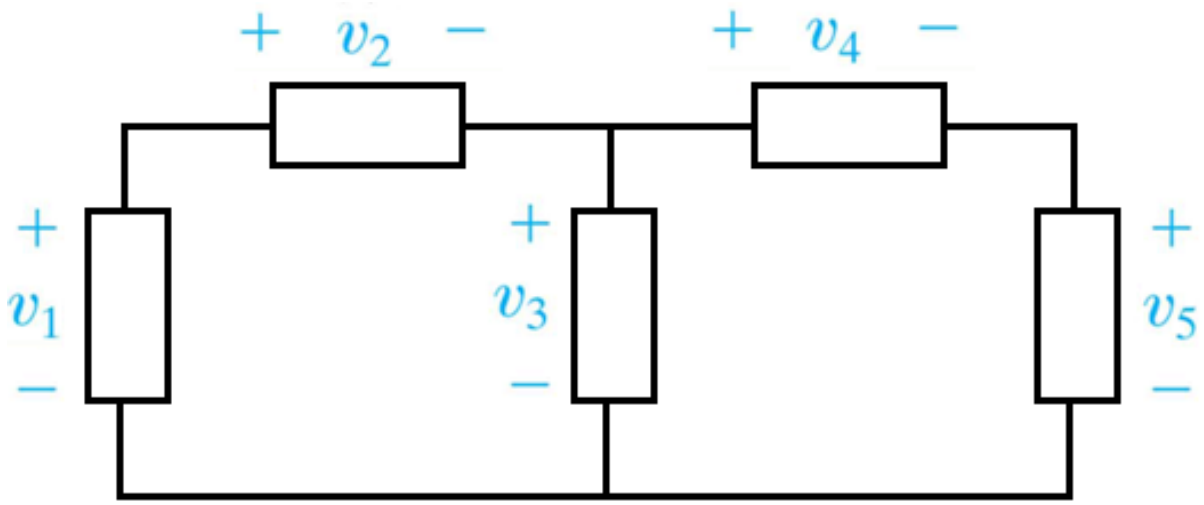






Ch2: Basic Laws – Kirchhoff's Laws – KVL

- **Example**



$$v_1 = 5V$$

$$v_2 = -3V$$

$$v_4 = 10V$$

$$v_3 \;\&\; v_5 = ?$$

Ch2: Basic Laws – Kirchhoff's Laws – KVL

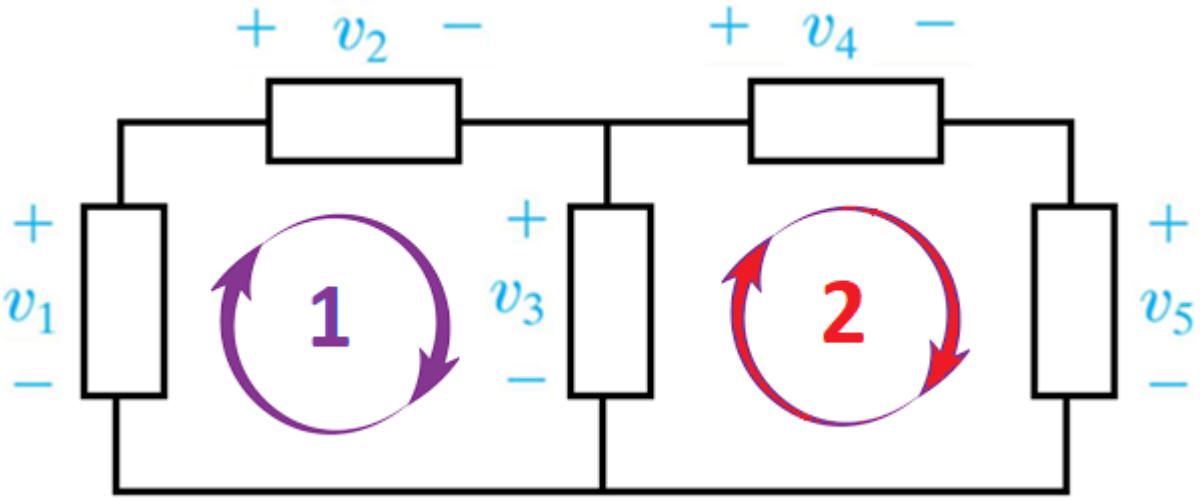
- **Example**

$v_1 = 5V$

$v_2 = -3V$

$v_4 = 10V$

v_3 & $v_5 = ?$



In loop1 $\rightarrow -V_1 + V_2 + V_3 = 0 \rightarrow -5 + (-3) + V_3 = 0$ $\rightarrow V_3 = 8V$

In loop 2 $\rightarrow -V_3 + V_4 + V_5 = 0 \rightarrow -8 + 10 + V_5 = 0$ $\rightarrow V_5 = -2V$

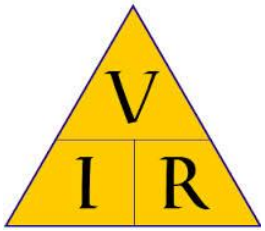
Check with KVL in big loop $\rightarrow V_1, V_2, V_4$ and V_5

$\rightarrow -V_1 + V_2 + V_4 + V_5 = 0 \rightarrow -5 - 3 + 10 - 2 = 0$ $\rightarrow 0 = 0$

Ch2: Basic Laws – OHM's Law & Kirchhoff's Laws

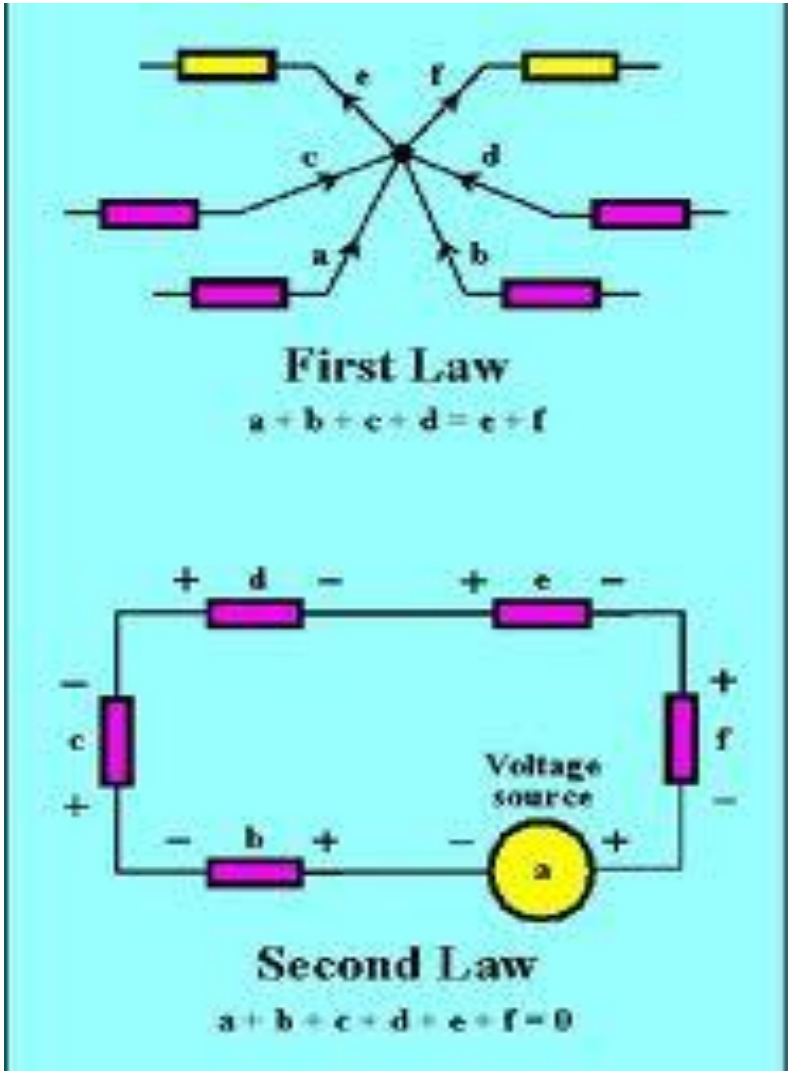
- **OHM's Law:** The voltage ***v*** *across a resistor is directly proportional* to the current ***i*** *flowing through the resistor.*

$$v = i.R$$



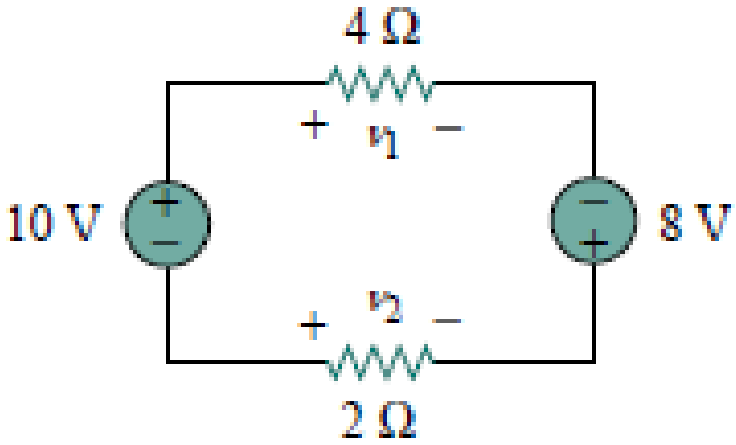
- **KCL:** The algebraic sum of all the currents at any node in a circuit equals zero.

- **KVL:** The algebraic sum of all the voltages around any closed path in a circuit equals zero.



Ch2: Basic Laws – Kirchhoff's Laws – KCL

- **Example**



$v_1 = ?$

$v_2 = ?$

- **Solution:**

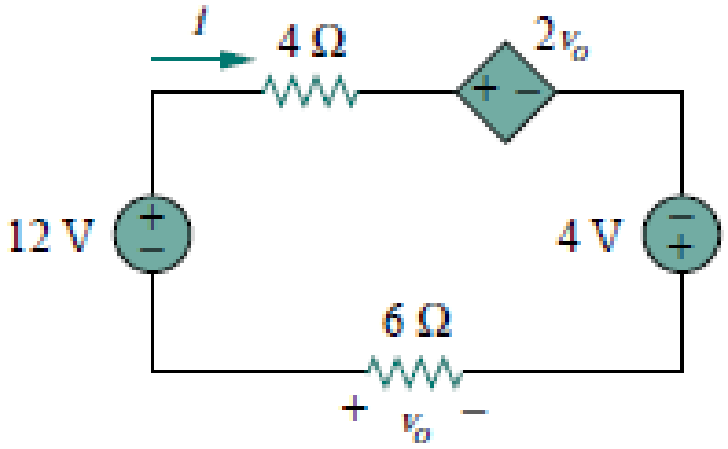
$$V_{total} = V_1 + V_2 = 10 + 8 = 18\,V \Longrightarrow I_{total} = \frac{V_{total}}{R_{total}} = \frac{18}{R_1 + R_2} = \frac{18}{6} = 3A$$

$$V_1 = +I_{total} x 4\Omega = +3x4 = 12V$$

$$V_2 = -I_{total} x 2\Omega = -3x2 = -6V$$

Ch2: Basic Laws – Kirchhoff's Laws – KCL

- **Example**



$i = ?$ $v_0 = ?$

- **Solution:**

$Let's\ write\ KVL\ inside\ loop$ $-12V + 4i + 2v_0 - 4V - v_0 = 0$

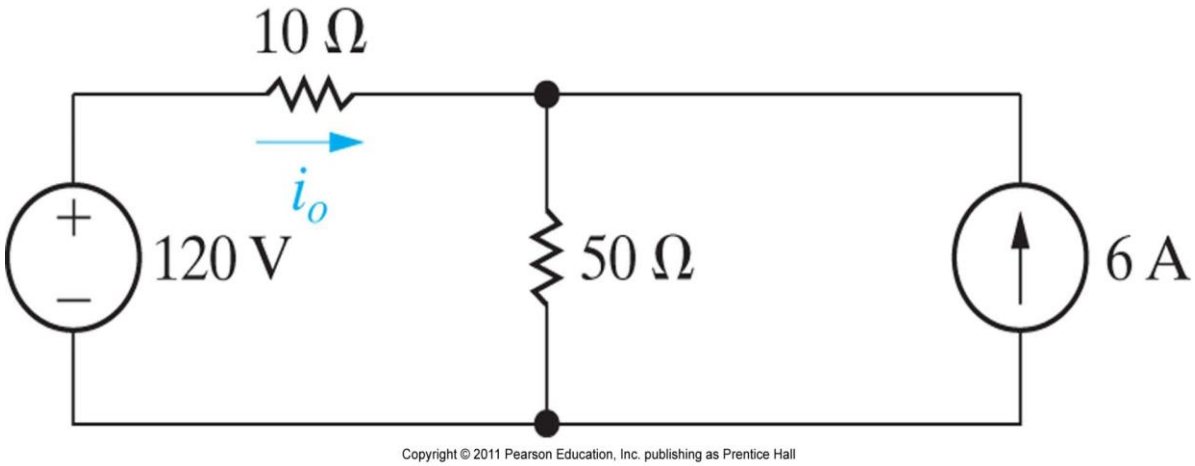
$4i + v_0 = 16\,V \ldots\ldots (1)$

$v_0\ is\ defined\ as\ the\ voltage\ across\ 6\Omega \rightarrow -v_0 = 6i \ldots\ldots\ldots\ldots (2)$

$\text{from } (2) \rightarrow v_0 = -6i \quad insert\ this\ into\ (1) \rightarrow i = -8A\ \&\ v_0 = 48V$

Ch2: Basic Laws – Kirchhoff's Laws – KCL

- **Example** (Example 2.8 from textbok)



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a) Use Kirchhoff's laws and Ohm's law to find i_0
b) Test the solution for i_0 *by verifying that the total* power generated equals the total power dissipated.

- **Solution:**

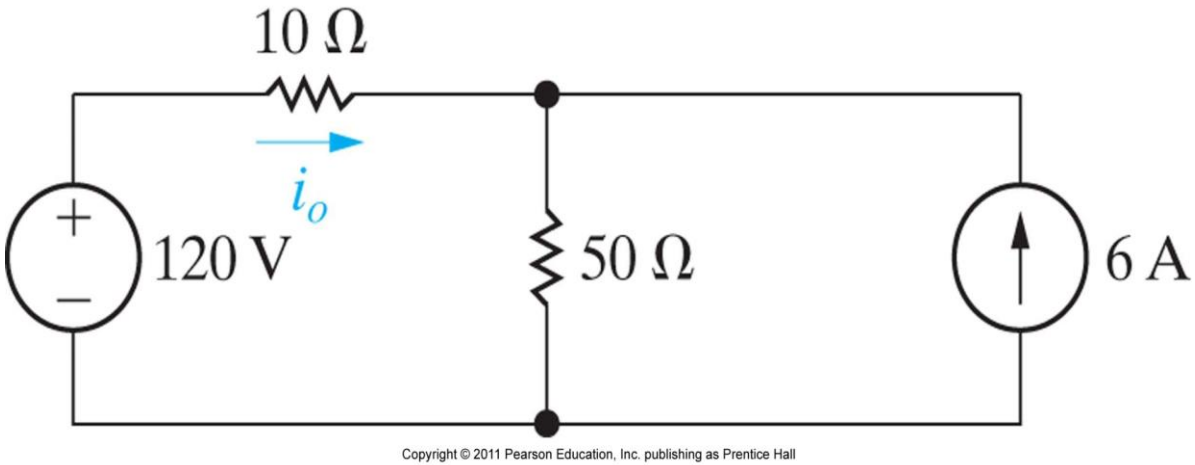
$$a) KVL\ inside\ left\ loop \rightarrow -120 + 10i_0 + V_{50} = 0$$

$$\rightarrow -120 + 10i_0 + 50(i_0 + 6) = 0$$

$$\rightarrow 60i_0 = -180 \rightarrow i_0 = -3A$$

Ch2: Basic Laws – Kirchhoff's Laws – KCL

- **Example** (Example 2.8 from textbok)



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b) Test the solution for i_0 *by verifying that the total* power generated equals the total power dissipated.

- **Solution:**

$b)$ *Calculate the power of each component* $P_{120V} = -120\ x\ i_0 = +360\text{W}$ diss. power

$P_{6A} = -6\ x\ V_{i_0} = -6 \text{ x } 50 \text{ x } (-3+6) = -900\text{W}$ sup. power

$P_{10} = +i_0^2 R = +90\text{W}$ diss. power

$P_{50} = +(6 + i_0\ )^2 50 = +450\text{W}$ diss. power

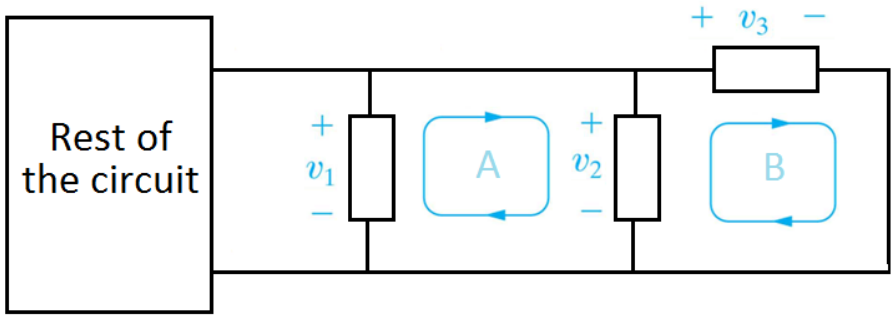
$$\sum P = 0$$



Ch2: Basic Laws – Parallel & Series Connections

- Two types of connections occur so frequently in circuit analysis that they deserve special attention.

- Two elements are said to be connected in **parallel** when they form a loop containing no other elements.



$$KVL@A \Rightarrow \boxed{v_1 = v_2}$$

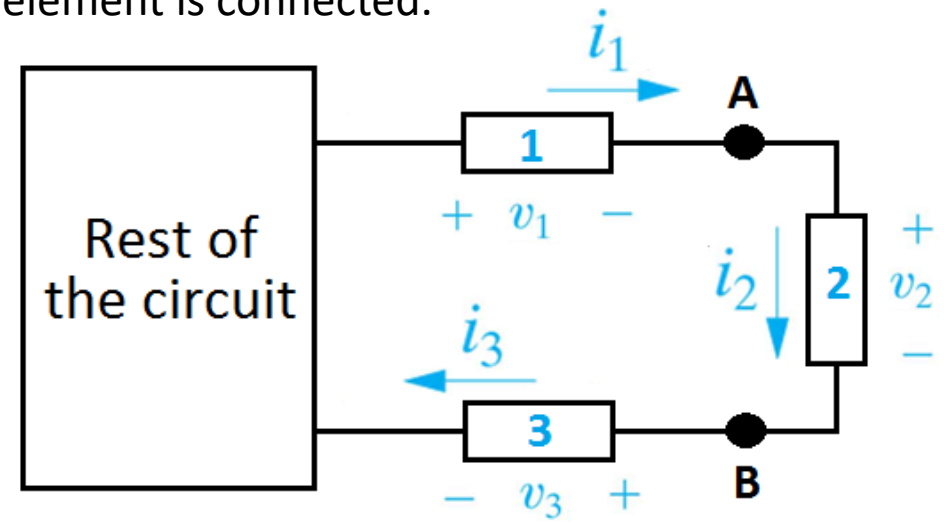
- In **parallel** connections, each element has equal voltages across its terminals.

$$KVL@B \Rightarrow \boxed{v_2 = v_3} \quad \Rightarrow \quad \boxed{v_1 = v_2 = v_3}$$

- In general, any number of elements connected between two common nodes are in **parallel** and as a result, the same voltage appears across each f them.

Ch2: Basic Laws – Parallel & Series Connections

- Two elements are said to be connected **series** when they have one common node to which no other element is connected.



$$KCL\ @\ A \Rightarrow i_1 - i_2 = 0 \quad \Rightarrow \quad i_1 = i_2$$

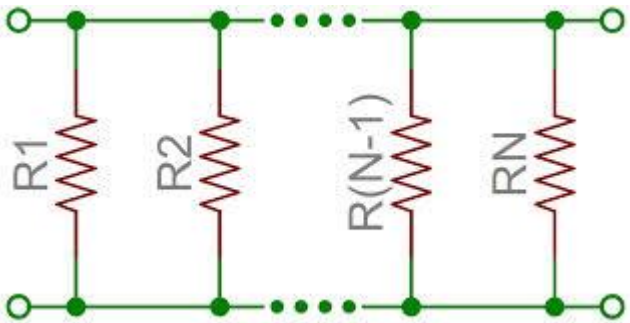
$$KCL\ @\ B \Rightarrow i_2 - i_3 = 0 \quad \Rightarrow \quad i_2 = i_3$$

$$i_1 = i_2 = i_3$$

- In **series** connection, KCL requires equal current through each element.

Ch2: Basic Laws – Parallel Connections of Resistors

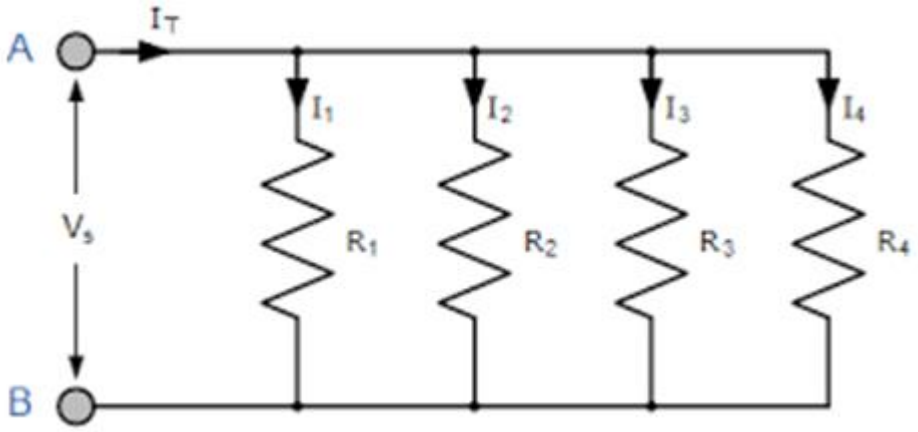
- When N resistors are in parallel,



$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_N}$$

$$G_{eq} = G_1 + G_2 + \cdots + G_N$$

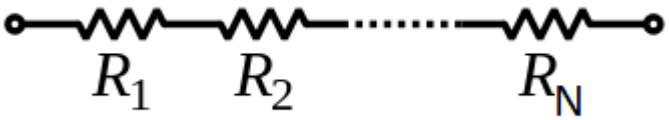
You can prove it by using KCL!!



- Note that the equivalent resistance is always smaller than the resistance of the smallest resistor in the parallel connection.

Ch2: Basic Laws – Series Connections of Resistors

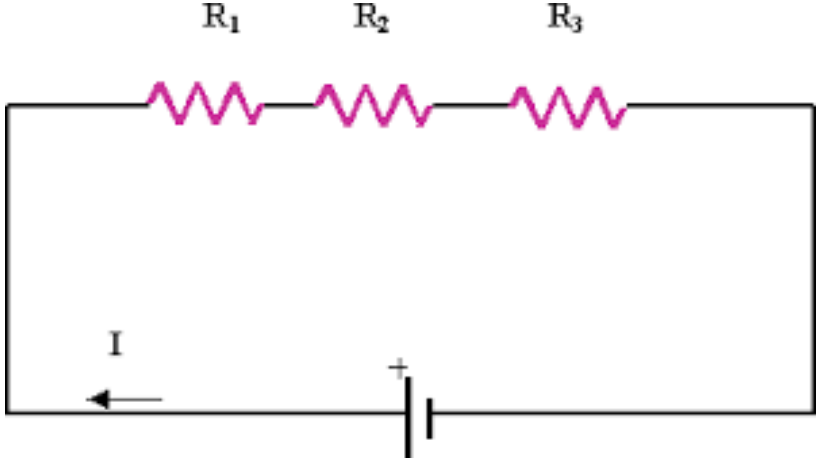
- When N resistors are in series,



$$R_{eq} = R_1 + R_2 + \cdots + R_N$$

$$\frac{1}{G_{eq}} = \frac{1}{G_1} + \frac{1}{G_2} + \cdots + \frac{1}{G_N}$$

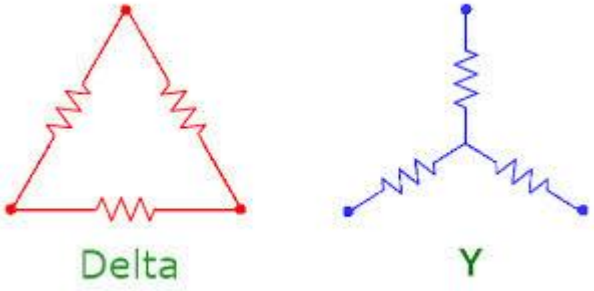
You can Prove it by using KVL!!

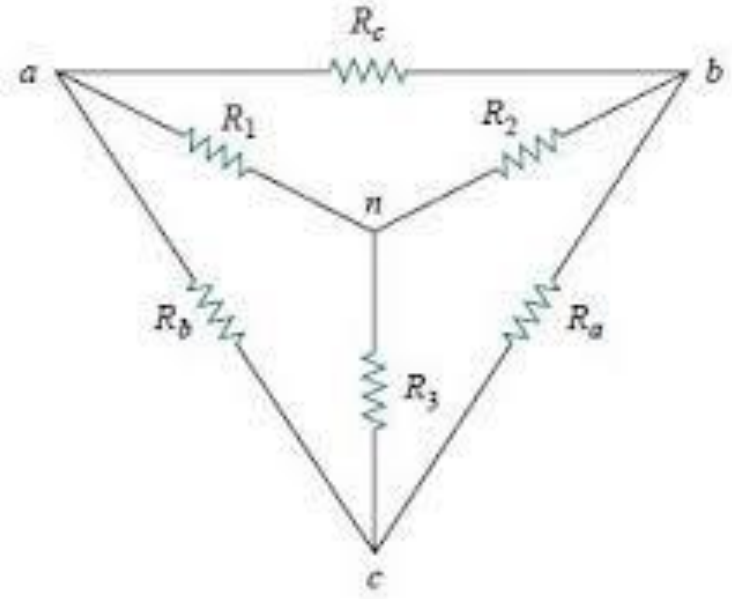


- Note that the equivalent resistance is always larger than the resistance of the largest resistor in the series connection.

Ch2: Basic Laws – Series Connections of Resistors

- **Special Case – Delta-to-Wye (Pi-to-Tee) (Δ-Y) Transformation**





$$R_1 = \frac{R_b R_c}{R_a + R_b + R_c}$$

$$R_2 = \frac{R_a R_c}{R_a + R_b + R_c}$$

$$R_3 = \frac{R_a R_b}{R_a + R_b + R_c}$$

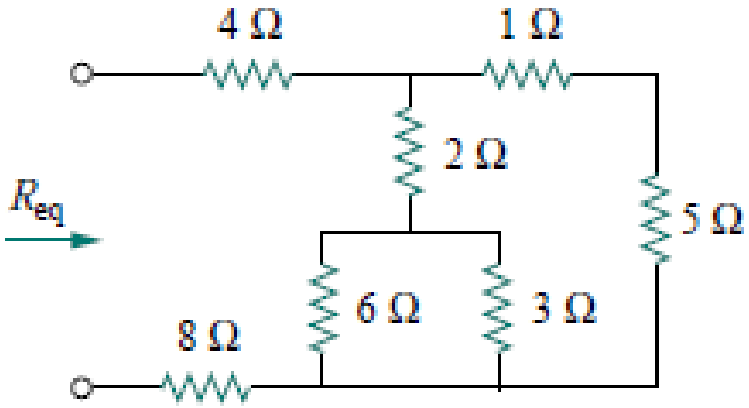
$$R_a = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_1}$$

$$R_b = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_2}$$

$$R_c = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_3}$$

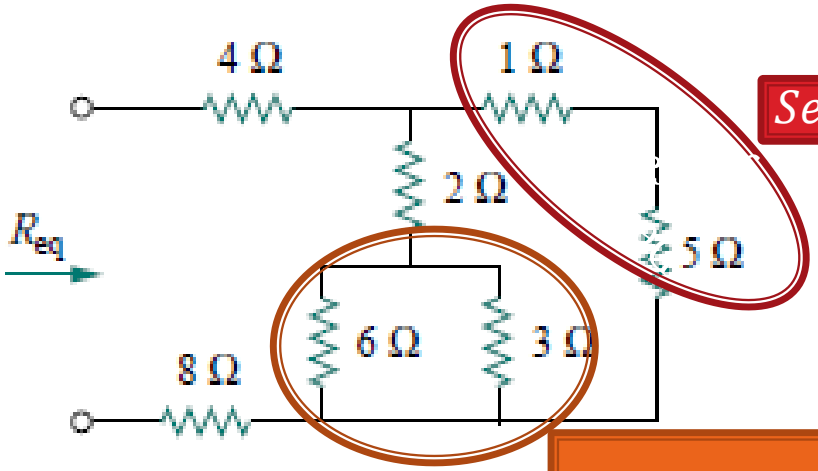
Ch2: Basic Laws – Series Connections of Resistors

- **Example**



$R_{eq} = ?$

- **Solution:**

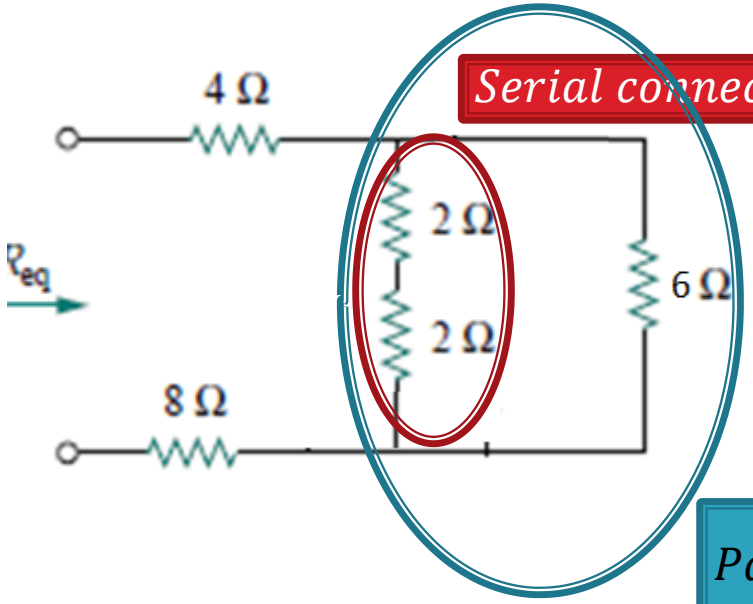


$Serial\ connection = 1 + 5 = 6\Omega$

$$Parallel\ connection = \frac{3x6}{3+6} = 2\Omega$$

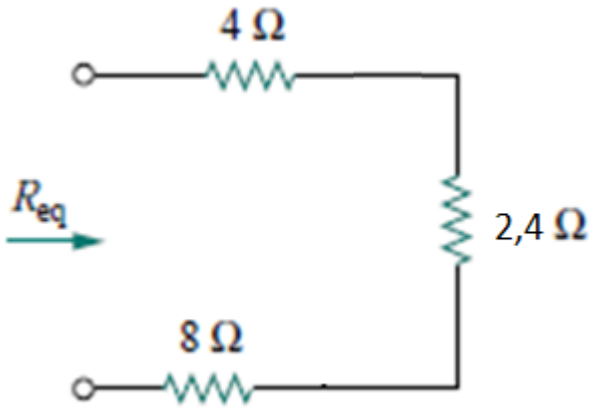
Ch2: Basic Laws – Series Connections of Resistors

- **Solution:**



$$Serial\ connection = 2 + 2 = 4\Omega$$

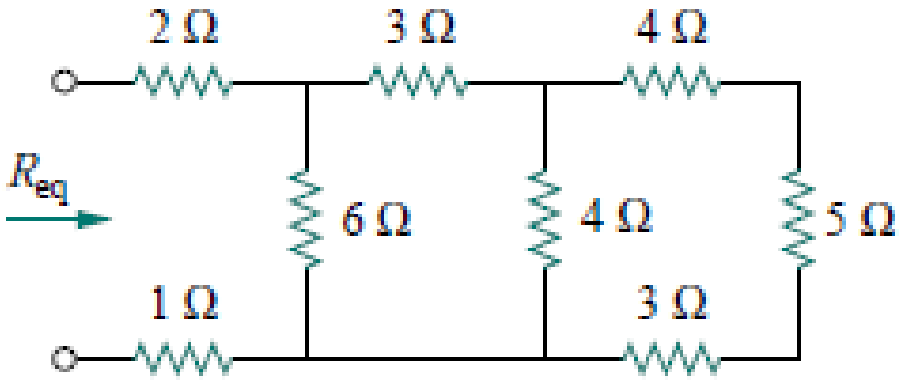
$$Parallel\ connection = \frac{4x6}{4+6} = 2{,}4\Omega$$



$$R_{eq} = 4 + 8 + 2{,}4 = 14{,}4\Omega$$

Ch2: Basic Laws – Series Connections of Resistors

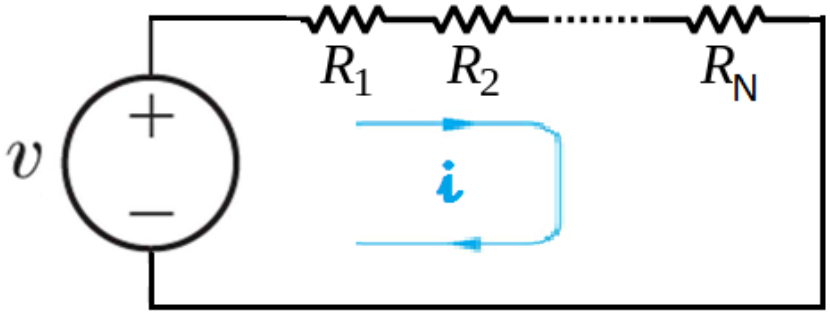
- **Example**



$$Answer: R_{eq} = 6\,\Omega$$

Ch2: Basic Laws – Voltage & Current Division

- **A Voltage Divider** is nothing but a series connection of resistors.



$$i = \frac{v}{R_{eq}} = \frac{v}{R_1 + R_2 + \cdots + R_N}$$

$$v_1 = i.R_1 = \frac{v}{R_1 + R_2 + \cdots + R_N}.R_1 = \frac{R_1}{R_{eq}}v$$

$$v_2 = i.R_2 = \frac{v}{R_1 + R_2 + \cdots + R_N}.R_2 = \frac{R_2}{R_{eq}}v$$

$$\vdots$$

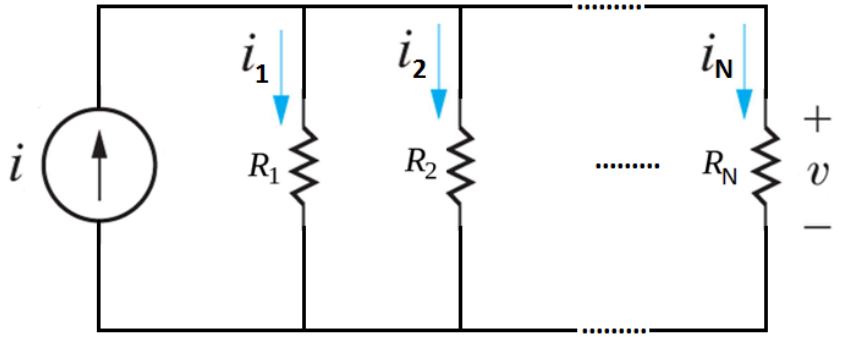
$$v_N = i.R_N = \frac{v}{R_1 + R_2 + \cdots + R_N}.R_N = \frac{R_N}{R_{eq}}v$$

- **The General expression of the voltage division rule is;**

$$v_k = \left(\frac{R_k}{R_{eq}}\right)v$$

Ch2: Basic Laws – Voltage & Current Division

- **A Curent Divider** is nothing but a paralel connection of resistors.



$$v = i.R_{eq} = i.\frac{1}{\left(\frac{1}{R_1}+\frac{1}{R_2}+\cdots+\frac{1}{R_N}\right)}$$

$$i_1 = \frac{v}{R_1} = \frac{i.R_{eq}}{R_1} = \left(\frac{R_2 R_3 \cdots R_N}{R_1+R_2+\cdots+R_N}\right) i$$

$$i_2 = \frac{v}{R_2} = \frac{i.R_{eq}}{R_2} = \left(\frac{R_1.R_3 \cdots R_N}{R_1+R_2+\cdots+R_N}\right) i$$

$$\vdots$$

$$i_N = \frac{v}{R_N} = \frac{i.R_{eq}}{R_N} = \left(\frac{R_1.R_2 \cdots R_{N-1}}{R_1+R_2+\cdots+R_N}\right) i$$

❑**The General expression of the current division rule is;**

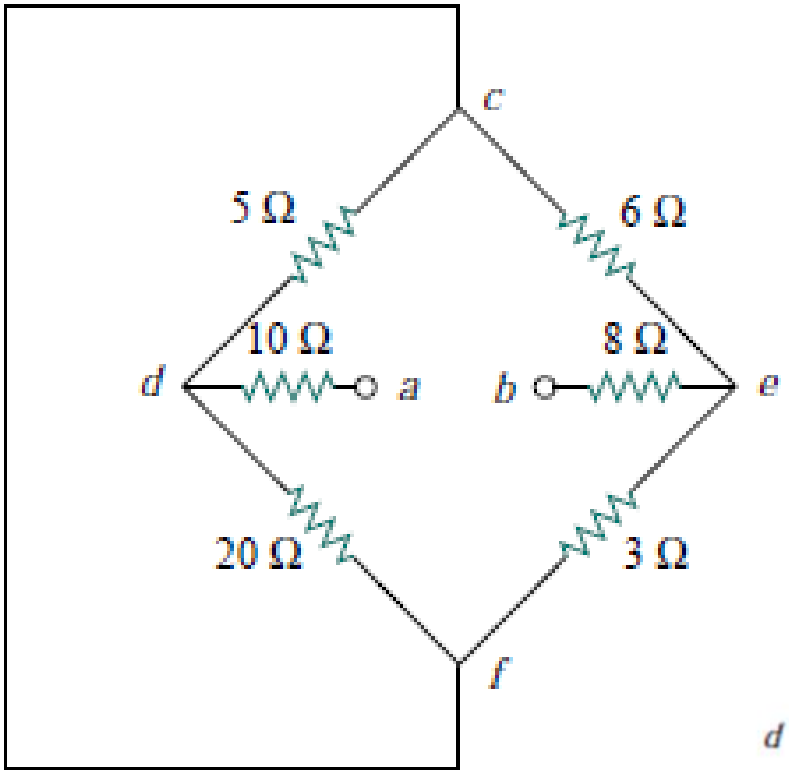
$$i_k = \left(\frac{R_1 R_2 \cdots R_{k-1} R_{k+1} \cdots R_N}{R_1+R_2+\cdots+R_N}\right) i$$

$$i_k = \frac{G_k}{G_{eq}} i$$

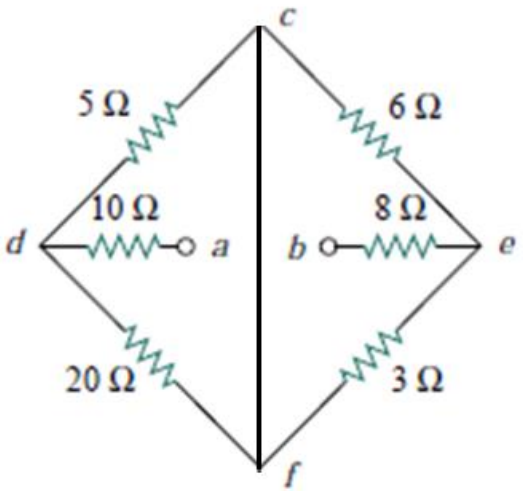
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Ch2: Basic Laws – Series Connections of Resistors

- **Example**



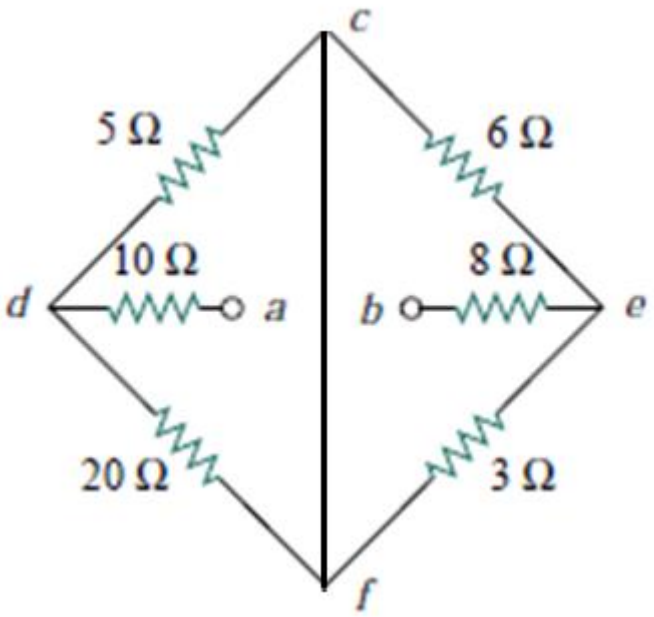
$$R_{ab} = ?$$

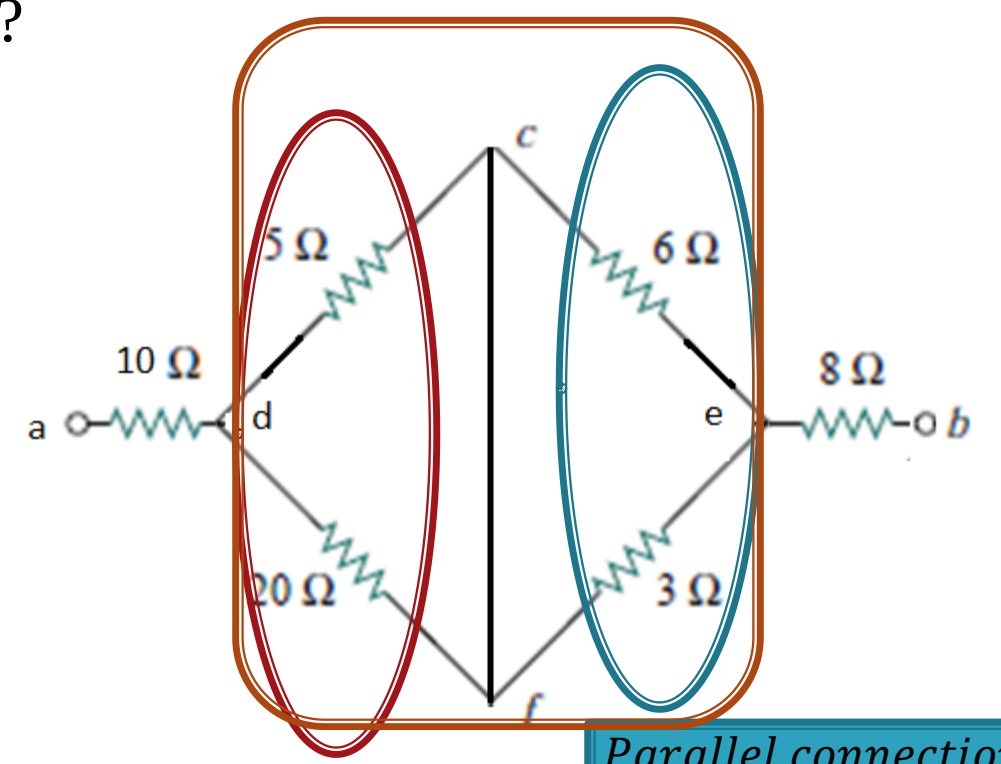


Ch2: Basic Laws – Series Connections of Resistors

- **Example**

$$R_{ab} = ?$$





$$Parallel\ connection = \frac{5x20}{5+20} = 4\Omega$$

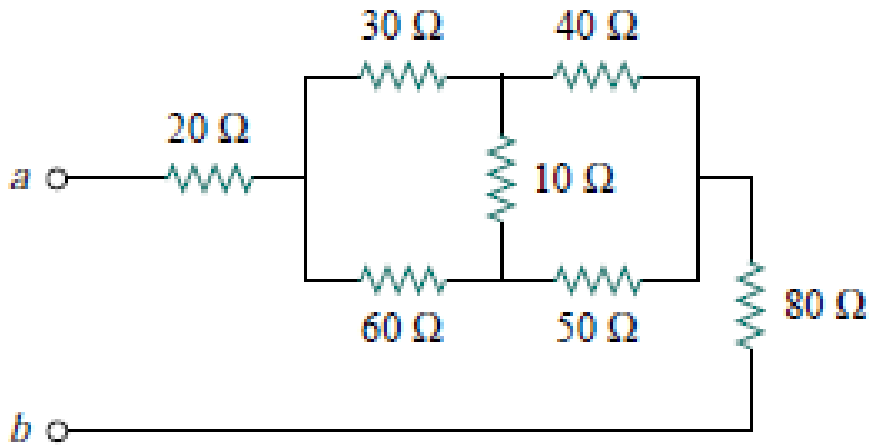
$$Parallel\ connection = \frac{6x3}{6+3} = 2\Omega$$

$$Series\ connection = 2 + 4 = 6\Omega$$

$$Finally;\ R_{ab} = 10 + 6 + 8 = 24\Omega$$

Ch2: Basic Laws – Series Connections of Resistors

- **Example**

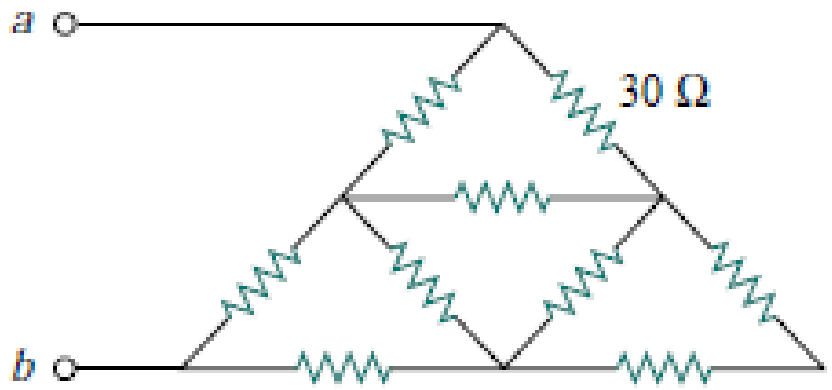


$R_{ab} = ?$

$Answer: R_{ab} \cong 142.3\,\Omega,$

Ch2: Basic Laws – Series Connections of Resistors

- **Example**

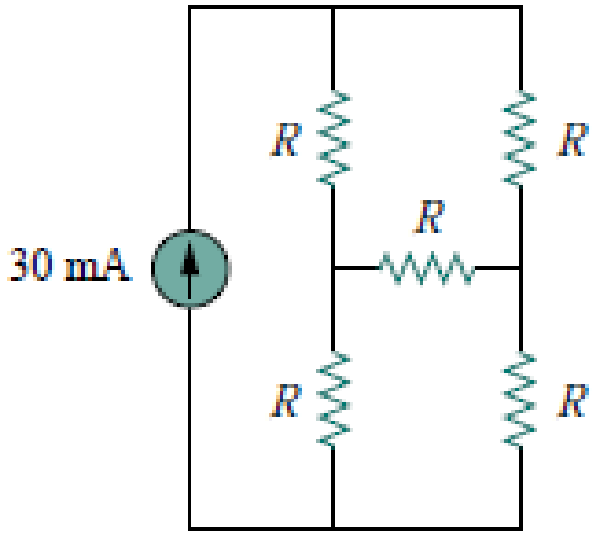


$All\ resistors\ are\ 30\Omega. \quad R_{ab} = ?$

$Answer: R_{ab} \cong 33.33\ \Omega,$

Ch2: Basic Laws – Series Connections of Resistors

- **Example**

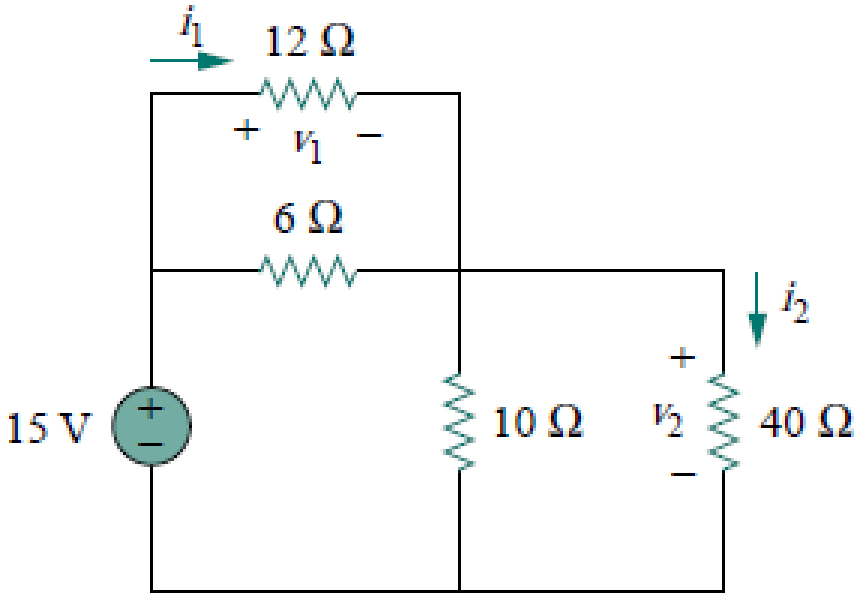


What value of *R would* cause the current source to deliver 800 mW to the resistors?

$$Answer: R \cong 888.9\ \Omega,$$

Ch2: Basic Laws

- **Example**



Find v_1 *and* v_2 *in the circuit . Also calculate* i_1 *and* i_2 and the power dissipated in the 12-Ω *and 40-Ω resistors.*

$$Answer: v_1 = 5\,\Omega,\ i_1 = 416.7mA,\ p_1 = 2.083W$$
$$v_2 = 10\,\Omega,\ i_1 = 250\,mA,\ p_1 = 2.5W$$

END OF CHAPTER 2

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