Chapter 2

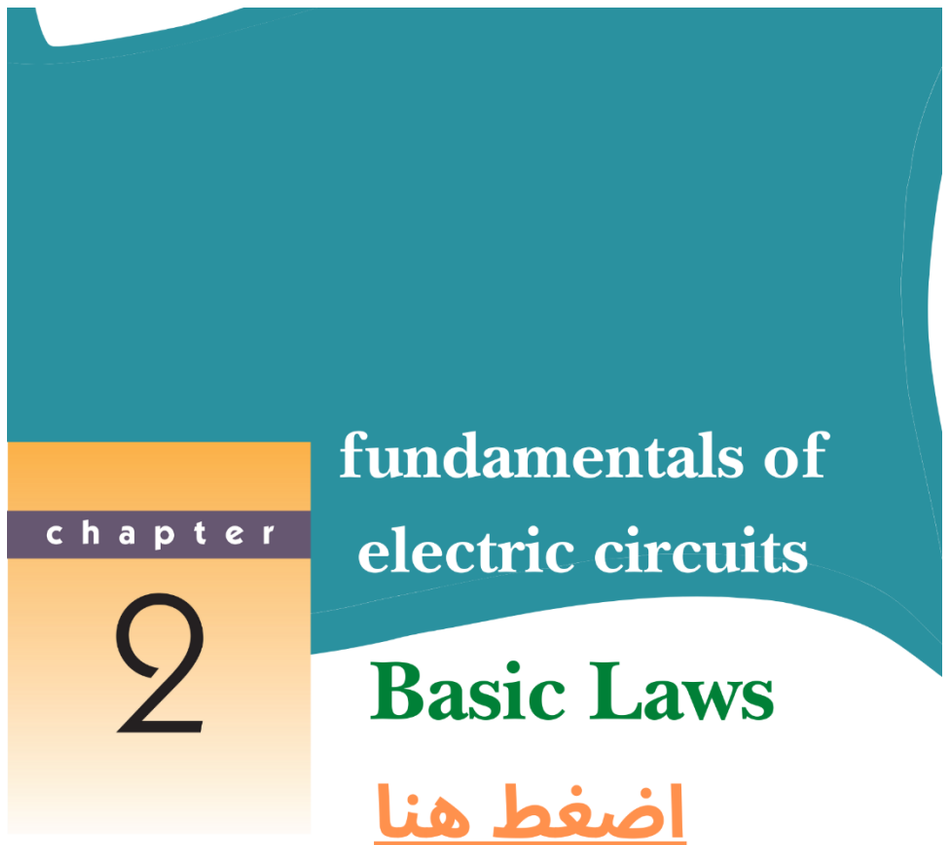
Basic Laws

رابط الكورس كامل علي موقع si-manual

https://si-manual.com/courses/si-electrical-circuits_1

رابط جروب التليجرام

https://t.me/circuit1_si



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2.1 Introduction

Content

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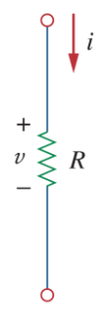
2.2 Ohm’s Law قانون أوم

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

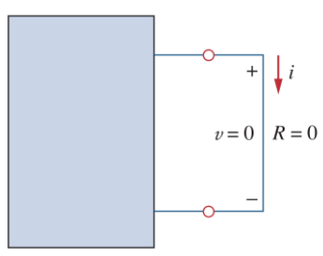
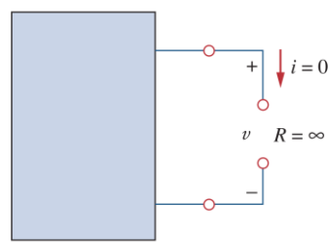
ينص قانون أوم على أن الجهد v عبر المقاومة يتناسب طرديًا مع التيار i المار بهذة المقاومة.

$$v = iR$$



The resistance R of an element denotes its ability to resist the flow of electric current; it is measured in ohms (Ω).

تشير المقاومة R لعنصر ما إلى قدرته على مقاومة مرور التيار الكهربائي و تقاس ب وحدةالأوم (Ω)

short circuit	open circuit
A short circuit is a circuit element with resistance approaching zero ($R \to 0$). الدائرة المغلقة هي دائرة مقاومتها تقترب من الصفر ($R \to 0$). 	An open circuit is a circuit element with resistance approaching infinity ($R \to \infty$). الدائرة المفتوحة هي دائرة مقاومتها تقترب من اللانهاية ($R \to \infty$) 

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

التوصيلية الكهربية هي قدرة العنصر على توصيل التيار كهربائي و تقاس بوحدة السيمنز (S).

$$G = \frac{1}{R} = \frac{i}{v}$$

$$p = vi = \frac{v^2}{R} = i^2R$$

- $v \to voltage\ (V)$
- $i \to current\ (A)$
- $R \to resistance\ (\Omega)$
- $G \to conductance\ (S)$
- $p \to power\ (W)$

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2.3 †Nodes, Branches, and Loops

A branch represents a single element such as a voltage source or a resistor.

A node is the point of connection between two or more branches.

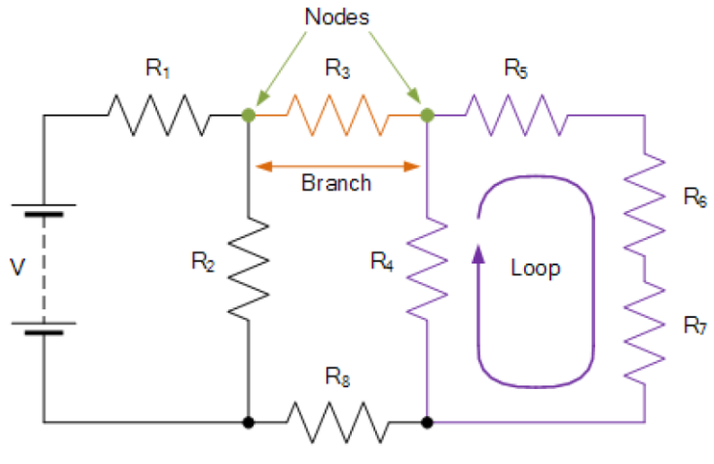
A loop is any closed path in a circuit.

A Mesh is a single closed loop series path that does not contain any other paths. There are no loops inside a mesh.

$$b = l + n - 1$$

- $l \rightarrow Number\ of\ loops$
- $n \rightarrow number\ of\ nodes$
- $b \rightarrow number\ of\ branches$ $(number\ of\ branches = number\ of\ circuits\ elements)$

التوصيل علي التوالي Series elements	التوصيل علي التوازي Parallel elements
Two or more elements are in series if they exclusively share a single node and consequently carry the same current. تكون العناصر متوصلة تواليا إذا كانوا يشتركون في نقطة واحدة وبالتالي يمر بهم نفس التيار.	Two or more elements are in parallel if they are connected to the same two nodes and consequently have the same voltage across them. تكون العناصر متوصلة توازيا إذا كانوا متصلين بنفس النقطتين وبالتالي يكون لهما نفس فرق الجهد.



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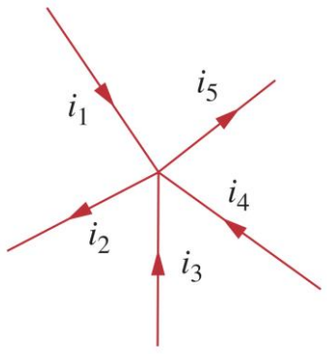
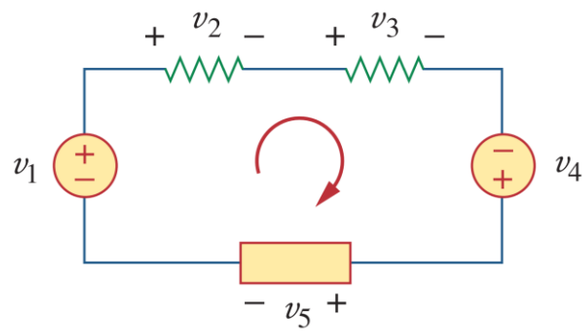
2.4 Kirchhoff's Laws

Kirchhoff's current law (KCL)	Kirchhoff's voltage law (KVL)
Kirchhoff's current law (KCL) states that the algebraic sum of currents entering a node (or a closed boundary) is zero. **مجموع التيارات الداخلة او الخارجة من أي نقطة في الدائرة = صفر** $\sum_{n=1}^{N} i_n = 0$ 	Kirchhoff's voltage law (KVL) states that the algebraic sum of all voltages around a closed path (or loop) is zero. **مجموع فروق الجهد في أي مسار مغلق في الدائرة = صفر** $\sum_{m=1}^{M} v_m = 0$ 

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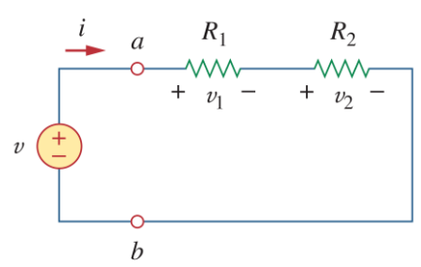
2.5 Series Resistors and Voltage Division

- Equivalent resistance R_{eq}

$$R_{eq} = R_1 + R_2 + .. + R_N$$

- Voltage division

$$v_1 = \frac{R_1}{R_1 + R_2} v, \qquad v_2 = \frac{R_2}{R_1 + R_2} v$$



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2.6 Parallel Resistors and Current Division

- Equivalent resistance R_{eq}

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

- Equivalent conductance G_{eq}

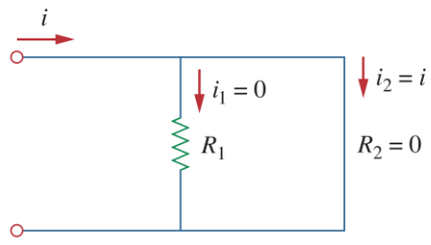
$$G_{eq} = G_1 + G_2 + \cdots + G_N$$

- Equivalent resistance R_{eq}(two resistance)

$$R_{eq} = \frac{R_1 R_2}{R_1 + R_2}$$

- Current division

$$i_1 = \frac{R_2}{R_1 + R_2} i, \qquad i_2 = \frac{R_1}{R_1 + R_2} i$$



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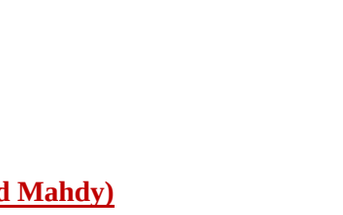
Series Resistors	Parallel Resistors
Series: same current but deferent voltage. توصيل التوالي : هي مجموعه مقاومات متتاليه يمر فيها التيار نفسه و لكن تختلف في الجهد.	Parallel: same voltage and deferent current. توصيل التوازي : هي مجموعه مقاومات متوازي تتصل في نقطتين و لها نفس الجهد و لكن التيار مختلف.
$R_{eq} = R_1 + R_2 + .. + R_N$	مجموعة مقاومات علي التوازي $R_{eq} = \left[\frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_N}\right]^{-1}$ مقاومتين علي التوازي $R_1 and\ R_2$ $R_{eq} = \frac{R_1 R_2}{R_1 + R_2}$ محصلة مقاومتين علي التوازي = ضربهم علي جمعهم لو كان المقاومتين متساويين $R_1 = R_2 = R$ $R_{eq} = \frac{R}{2}$ Equivalent conductance G_{eq} $G_{eq} = \frac{1}{R_{eq}} = G_1 + G_2 + \cdots + G_N$
Voltage division مقسم الجهد $v_1 = \frac{R_1}{R_1 + R_2} v, \qquad v_2 = \frac{R_2}{R_1 + R_2} v$ 	**Current division** مقسم التيار $i_1 = \frac{R_2}{R_1 + R_2} i, \qquad i_2 = \frac{R_1}{R_1 + R_2} i$

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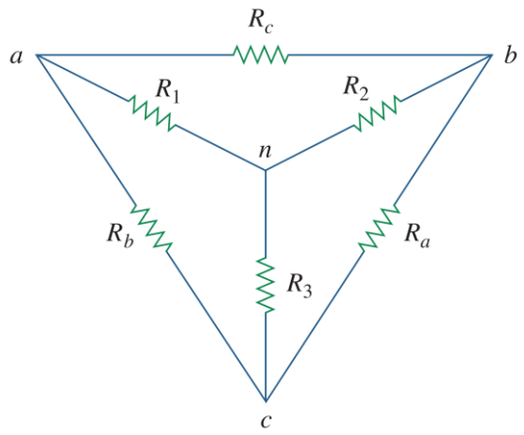
2.7 Wye-Delta Transformations



Δ to Y Conversion	**Y to Δ Conversion**
$R_1 = \frac{R_b R_c}{R_a + R_b + R_c}$	$R_a = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_1}$
$R_2 = \frac{R_a R_c}{R_a + R_b + R_c}$	$R_b = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_2}$
$R_3 = \frac{R_a R_b}{R_a + R_b + R_c}$	$R_c = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_3}$
when $R_a = R_b = R_c = R_\Delta$ $R_Y = \frac{R_\Delta}{3}$	*when* $R_1 = R_2 = R_3 = R_Y$ $R_\Delta = 3R_Y$

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Laws summery

Ohm's Law

$$v = iR$$

$$G = \frac{1}{R} = \frac{i}{v}$$

R → Resistance
G → conductance
i → current
v → voltage

Nodes, Branches, and Loops

$$b = l + n - 1$$

b → number of branches
n → number of nodes
l → number of loops

Kirchhoff's Laws

Kirchhoff's current law (KCL) states that the algebraic sum of currents entering a node (or a closed boundary) is zero.

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

Kirchhoff's voltage law (KVL) states that the algebraic sum of all voltages around a closed path (or loop) is zero.

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

Series Resistors and Voltage Division

- Equivalent resistance R_{eq}

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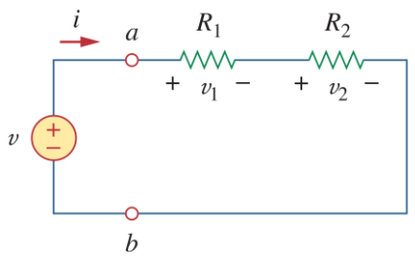
- Voltage division

$$v_1 = \frac{R_1}{R_1 + R_2} v, \qquad v_2 = \frac{R_2}{R_1 + R_2} v$$



Parallel Resistors and Current Division

- Equivalent resistance R_{eq}

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- Equivalent conductance G_{eq}

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

- Equivalent resistance R_{eq}(two resistance)

$$R_{eq} = \frac{R_1 R_2}{R_1 + R_2}$$

- Current division

$$i_1 = \frac{R_2}{R_1 + R_2} i, \qquad i_2 = \frac{R_1}{R_1 + R_2} i$$

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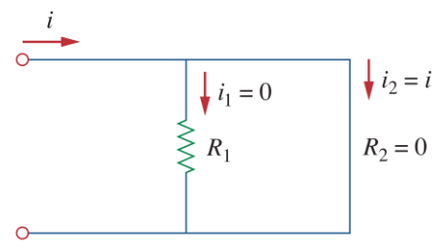
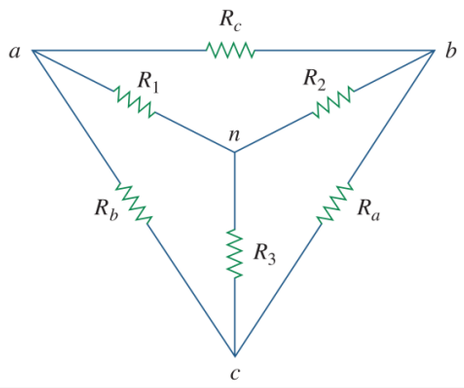


Y-Δ Transformations



Δ to Y Conversion	Y to Δ Conversion
$R_1 = \frac{R_b R_c}{R_a + R_b + R_c}$	$R_a = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_1}$
$R_2 = \frac{R_a R_c}{R_a + R_b + R_c}$	$R_b = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_2}$
$R_3 = \frac{R_a R_b}{R_a + R_b + R_c}$	$R_c = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_3}$

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