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Lecture Contents

$V = IR$

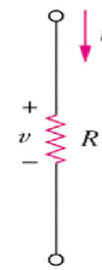
- Ohm's Law.
- Independent and Dependent Sources.
- Circuit Terminology.
- Kirchhoff's Current Law (KCL).
- Kirchhoff's Voltage Law (KVL).
- Short and Open Circuit.

Ohm's Law

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

- Mathematical expression for Ohm's Law is as follows:

$$v = iR$$



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.

الموصلية ، G S

- ***Conductance*** is the ability of an element to conduct electric current; it is the reciprocal of resistance R and is measured in mhos or siemens.

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

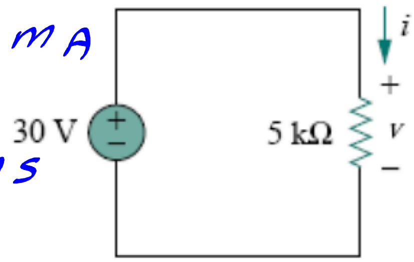
- The power dissipated by a resistor:

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

Example

- In the circuit shown in Fig. calculate the **current i**, the **conductance G**, and the **power P**.

$$I = \frac{V}{R} = \frac{30V}{5 * 10^3 \Omega} = 6 * 10^{-3} A = 6 mA$$



$$G = \frac{1}{R} = \frac{1}{5 * 10^3} = 0.2 * 10^{-3} S = 0.2 mS$$

$$P = I \cdot V = 6 * 10^{-3} * 30 = 0.18 W = 180 mW$$

Ohms Law

- **The resistance** of any material with a uniform cross-sectional area A depends on A, its length L , and resistivity of the material ρ.
- In mathematical form

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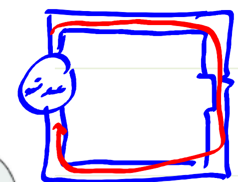
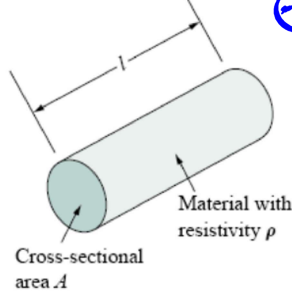


المقاومة النوعية

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

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



(a)

Resistivity of common materials

The next table presents the values of ρ for some common materials and shows which materials are used for conductors, insulators, and semiconductors.

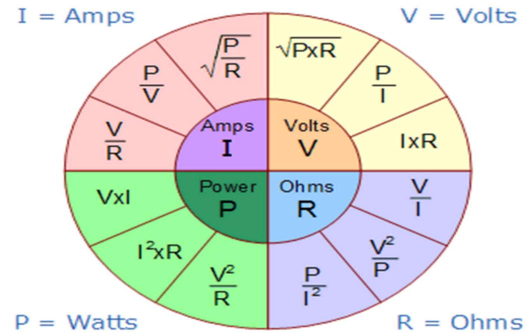
TABLE 2.1 Resistivities of common materials.

Material	Resistivity (Ω·m)	Usage
Silver	1.64×10^{-8}	Conductor
Copper	1.72×10^{-8}	Conductor
Aluminum	2.8×10^{-8}	Conductor
Gold	2.45×10^{-8}	Conductor
Carbon	4×10^{-5}	Semiconductor

TABLE 2.1 Resistivities of common materials.

Material	Resistivity (Ω·m)	Usage
Germanium	47×10^{-2}	Semiconductor
Silicon	6.4×10^{2}	Semiconductor
Paper	10^{10}	Insulator
Mica	5×10^{11}	Insulator
Glass	10^{12}	Insulator
Teflon	3×10^{12}	Insulator

Ohm's Law Conclusion



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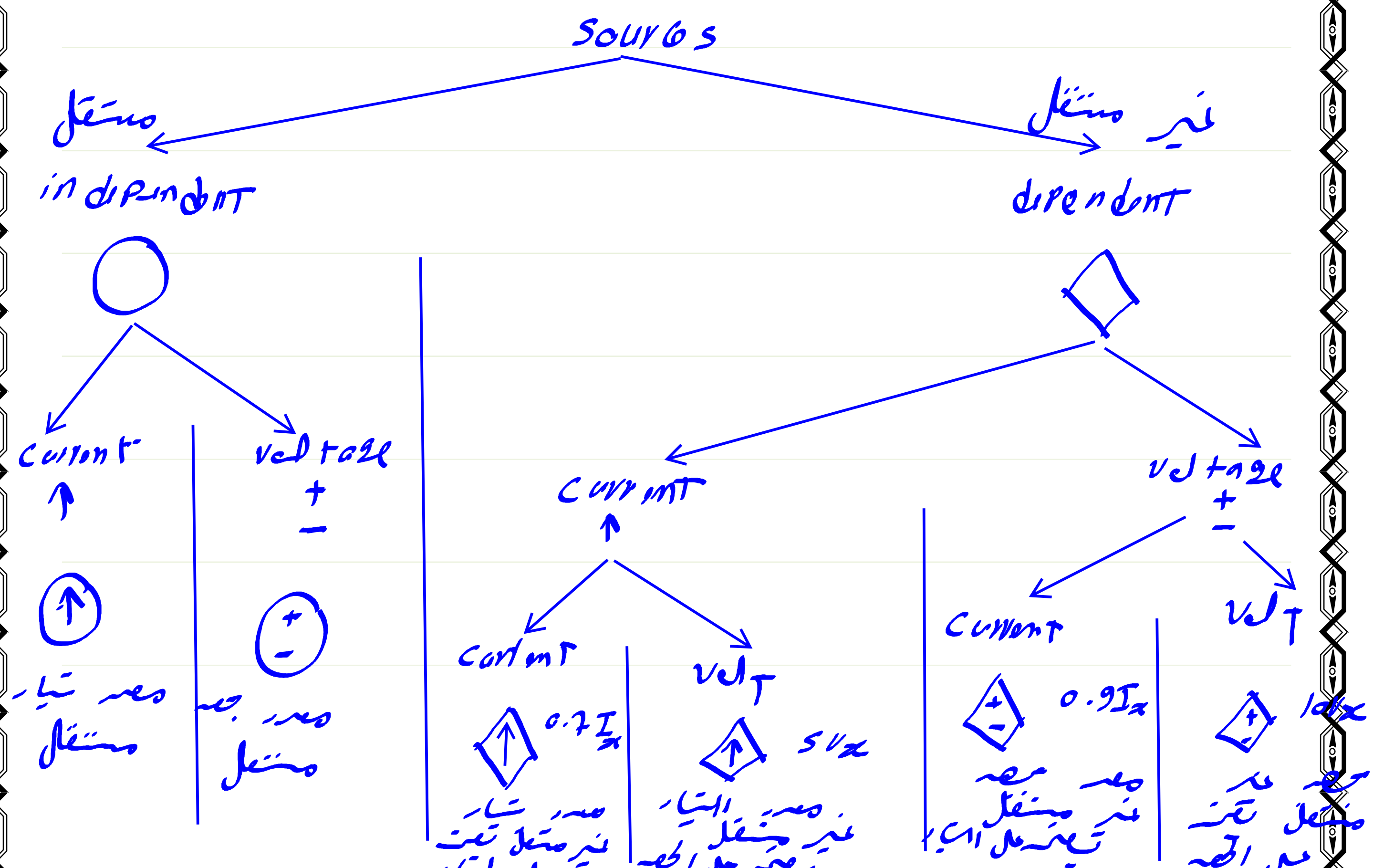
Independent vs. Dependent Sources

جهد تيار

There are two kinds of sources:

1. An independent source (voltage or current) may be DC (constant) or time-varying, but does not depend on other voltages or currents in the circuit.

2. A dependent source's value depends on another voltage or current in the circuit.



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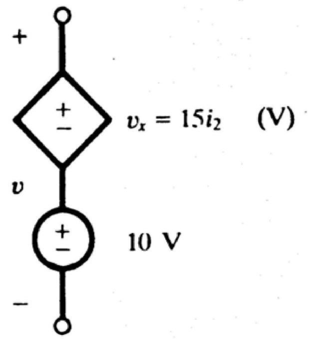
Example 2

Obtain the voltage v in the branch shown in the Figure for i_2 = 1A.

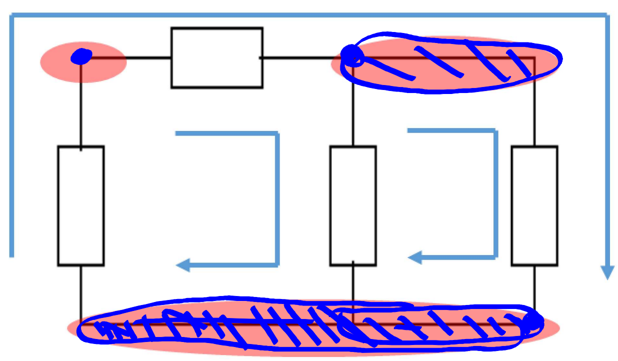


$V = 15 * 1 + 10 = 25V$

مصطلحات الدائرة

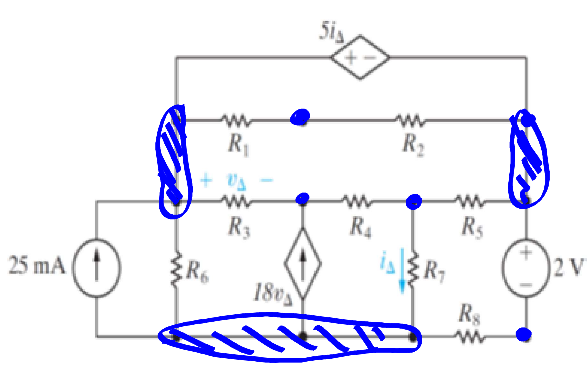
Circuit Terminology

- Node: A point where two or more elements join.
- Loop: Any closed path in a circuit.
- Mesh: A loop not containing other loops.



3 Node.
3 Loop.
2 Mesh.

Example: for the circuit shown in Figure, find the number of nodes, meshs, and loops:



7 nods
6 mesh
7 loops

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$i_1 + i_3 + i_4 = i_2 + i_5$

Kirchhoff's Current Law (KCL)

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

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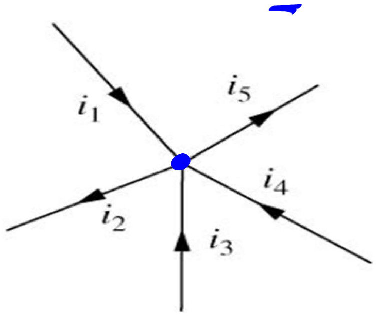
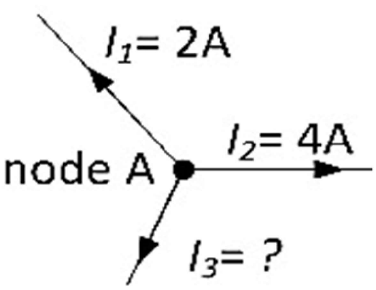


$$\sum_{n=1}^{N} i_n = 0$$

$-i_1 + i_2 - i_3 - i_4 + i_5 = 0$

Example for KCL

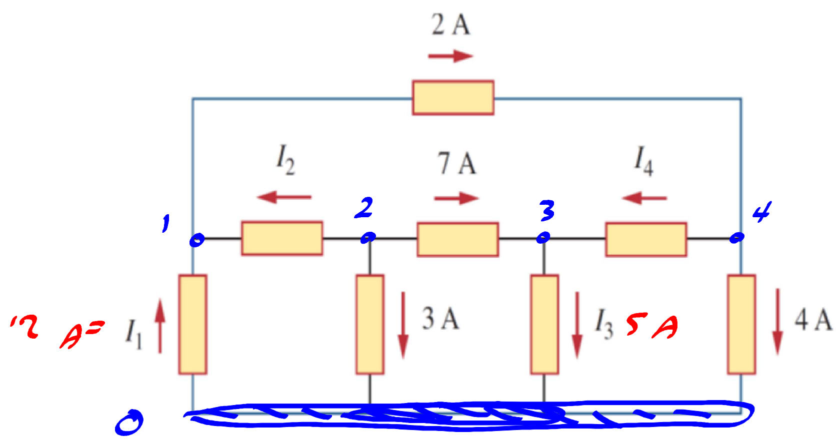


$i_3 + i_2 + i_1 = 0$

$i_3 + 4 + 2 = 0$

$i_3 = -6A$

Example1: For the circuit, use KCL to find the branch currents I_1 to I_4:



apply K.C.L at node 1

$-I_1 - I_2 + 2 = 0 \Rightarrow -I_1 - (-10) + 2 = 0 \Rightarrow I_1 = 12A$

apply K.C.L at node 2

$I_2 + 3 + 7 = 0 \Rightarrow I_2 = -10A$

apply K.C.L at node 4

$-2 + I_4 + 4 = 0 \Rightarrow I_4 = -2A$

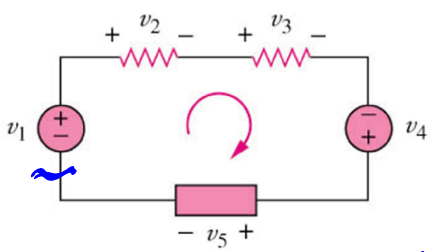
apply K.C.L at node 3

$-7 + I_3 - (-2) = 0 \Rightarrow I_3 = 5A$

K.V.L

KIRCHHOFF VOLTAGE LAW

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



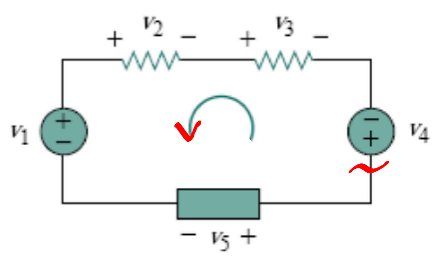
Mathematically,

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

$-V_1 + V_2 + V_3 - V_4 + V_5 = 0$

Ex. write the KVL for the circuit shown

$V_4 - V_3 - V_3 + V_1 - V_5 = 0$



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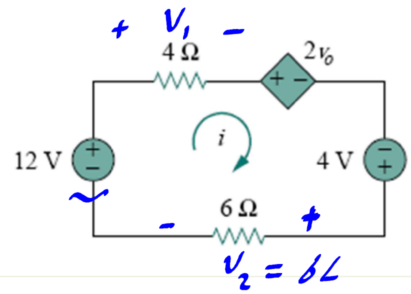
$V = IR$

Example 1

If $V_o = -6i_o$, determine *i and* Vo in the circuit shown in Fig.



apply K.V.L

$$-12 + \overset{4i}{V_1} + \overset{-6i}{2\cancel{V_o}} - 4 + \overset{6i}{V_2} = 0$$

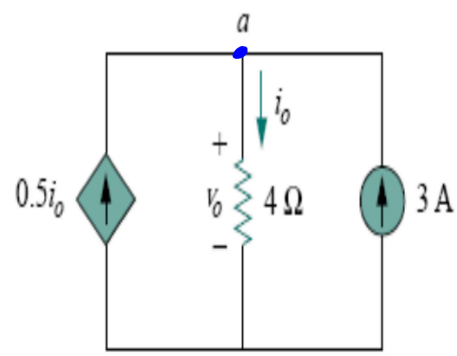
$$-2i = 16$$

$$i = -8A$$

$$V_o = -6(-8) = 48\,V$$

Example 2

Find current **I** and voltage **V** in the circuit shown in Fig.



apply K.C.L at a

$$-0.5i_o + i_o - 3 = 0$$

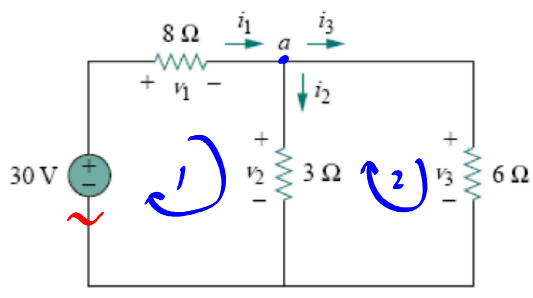
$$0.5i_o = 3 \Rightarrow i_o = 6A$$

$$V_o = 6 * 4 = 24V$$

$V = IR$, K.C.L, K.V.L

Example 3

Find the currents and voltages in the circuit shown in Fig. (a).



(a)

apply K.C.L at node a

$-i_1 + i_2 + i_3 = 0 \rightarrow (1)$

apply K.V.L at mesh 1

$-30 + \overset{8i_1}{v_1} + \overset{3i_2}{v_2} = 0$

$8i_1 + 3i_2 = 30 \rightarrow (2)$

apply K.V.L at mesh 2

$-\overset{3i_2}{v_2} + \overset{6i_3}{v_3} = 0$

$-3i_2 + 6i_3 = 0 \rightarrow (3)$

$v_1 = 24V$, $v_2 = 6V$, $v_3 = 6V$

$-i_1 + i_2 + i_3 = 0$

$8i_1 + 3i_2 = 30$

$-3i_2 + 6i_3 = 0$

$i_1 = 3A$, $i_2 = 2A$, $i_3 = 1A$