

Ministry of Higher Education and Scientific Research Tikrit University Engineering Collage –Al shirqat

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FUNDAMENTALS OF ELECTRICAL ENGINEERING LECTURE 2 KIRCHHOFF'S LAWS

Classroom: xtofyek4 الصباحي Classroom: cftcvpvp

PREPARED BY TEACHING ASSISTANT

ABDULLAH AHMED ALWAN

## **General Objectives:**

•Understanding the Basics of Electrical Circuits: Enhance students' comprehension of the fundamental principles governing current and voltage flow in electrical circuits.

- •Interpreting and Solving Complex Circuits: Enable students to analyze electrical circuits with multiple branches and paths using Kirchhoff's Current and Voltage Laws.
- •Connecting Kirchhoff's Laws with Ohm's Law: Clarify the relationship between Kirchhoff's Laws and Ohm's Law for a deeper understanding of electrical circuits.
  •Practical Application of Kirchhoff's Laws: Help students apply these laws in designing and analyzing electrical and electronic systems.
- •**Preparing Students for Advanced Studies:** Provide a solid foundation for studying advanced electrical circuits and electronics.

# **Specific objectives:**

- •Understanding the Fundamental Laws: Comprehend Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL) and understand how to apply them in electrical circuit analysis.
- •Electrical Circuit Analysis: Enable students to analyze complex circuits with multiple current paths and sources.
- •Solving Complex Circuits: Use Kirchhoff's laws to solve circuits that cannot be analyzed using Ohm's law alone.
- •**Practical Applications:** Apply Kirchhoff's laws in engineering and electronics applications, such as circuit design and troubleshooting.
- •Utilizing Modern Tools and Techniques: Employ simulation software and laboratory equipment to test the validity of the laws and their applications.

### Introduction

The general and specific objectives help achieve a comprehensive understanding of Ohm's Law from both theoretical and practical perspectives, enabling students to use it effectively in various real-life situations and in the study of electrical sciences.

### 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 network with b branches, n nodes, and L independent

loops will satisfy the fundamental theorem of network topology: **b** 

$$b = l + n - 1$$





### Nodes, Branches, and Loops

 $\succ$  Two or more elements are in **series** if they exclusively share a single node 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.



**Kirchhoff's current law (KCL)**: The algebraic sum of all the

currents at any node in a circuit equals zero.

Mathematically, KCL implies that

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

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

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



#### ≻Kirchhoff's current law (KCL)

 $I_T + I_2 = I_1 + I_3$ 

 $I_T = I_1 - I_2 + I_3$ 



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

Expressed mathematically, KVL states that

$$\sum_{m=1}^{M} v_m = 0$$
$$-v_1 + v_2 + v_3 - v_4 + v_5 = 0$$



 $v_2 + v_3 + v_5 = v_1 + v_4$ 

Sum of voltage drops Sum of voltage rises  $-v_{ab} + v_1 + v_2 - v_3 = 0$  $v_{ab} = v_1 + v_2 - v_3$ 

Exmpel 6: find voltages  $v_1$  and  $v_2$  for the circuit in Fig.a?  $b \overline{}$  Solution:

To find and we apply Ohm's law and Kirchhoff's voltage law.  $v_1 = 2i$ ,  $v_2 = -3i$ 

Apply KVL

 $\begin{array}{l} -20 + v_1 - v_2 = 0 \\ -20 + 2i + 3i = 0 \text{ or } 5i = 20 \Rightarrow i = \frac{20}{5} = 4Amp. \\ v_1 = 2i = 2 * 4 = 8 \text{ V} \\ v_2 = -3i = -3 * 4 = -12 \text{ V} \end{array}$ 

