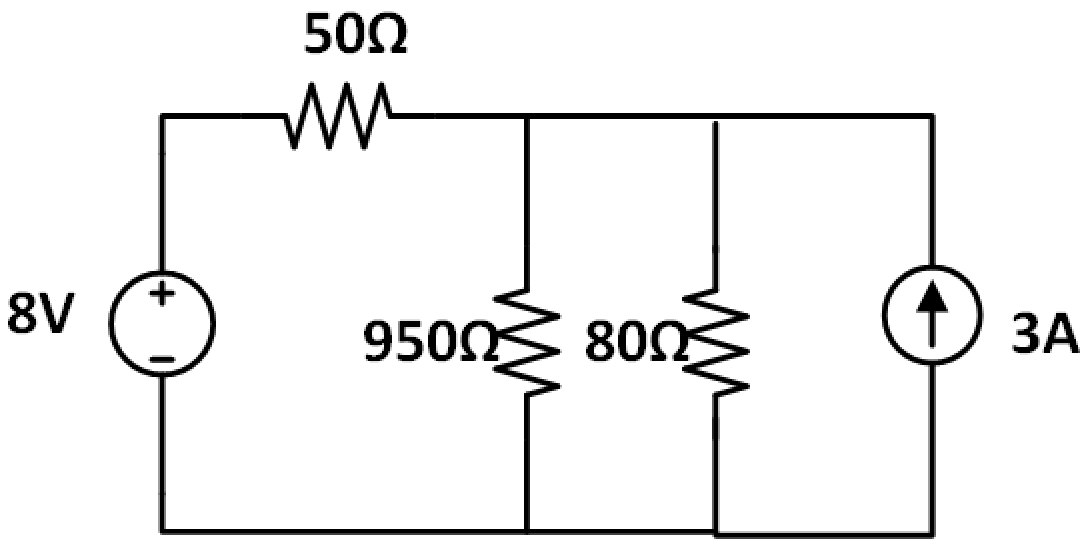
Nodes Branches and Loops

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

$$\boxed{b = l + n - 1}$$

In Fig:
Branches?
Nodes?
Independent loops?



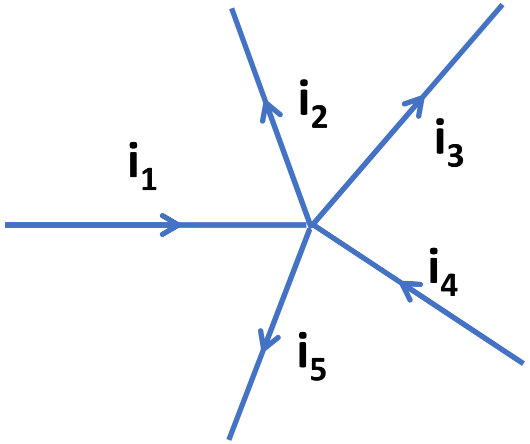
Kirchhoff’s Current Law (KCL)

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

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

- The sum of the currents entering a node is equal to the sum of the currents leaving the node.

- By this law, currents entering a node may be regarded as positive, while currents leaving the node may be taken as negative or vice versa.



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

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

Kirchhoff’s Voltage Law (KVL)

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

$$\boxed{\sum_{m=1}^{M} i_m = 0}$$

- In any closed loop, sum of voltage drops is equal to the sum of voltage rises.

- The sign on each voltage depends on the polarity of the terminal encountered first. The loop may be considered either clockwise or counterclockwise. Suppose, we start with the voltage source v1 and go clockwise around the loop; then voltages would be $-v_1$, $+v_2$, $+v_3$, $-v_4$, and $+v_5$, in that order. For example, as we reach branch 3, the positive terminal is met first; hence we have $+v_3$. For branch 4, we reach the negative terminal first; hence, $-v_4$.