What is Electric Current?

The **electric current** is the rate of flow of electric charge through a conducting medium with
respect to time.

When there is a potential difference between two points in a conductive medium, electric
charge starts flowing from the higher potential point to the lower potential point to balance the
charge distribution between the points. The rate of flow of charge in respect of time is known as
electric current.

urrent Formula

q Coulomb electric charge gets transferred between these two points
me t sec, then the
urrent can be calculated as
n differential form, the current can be represented as

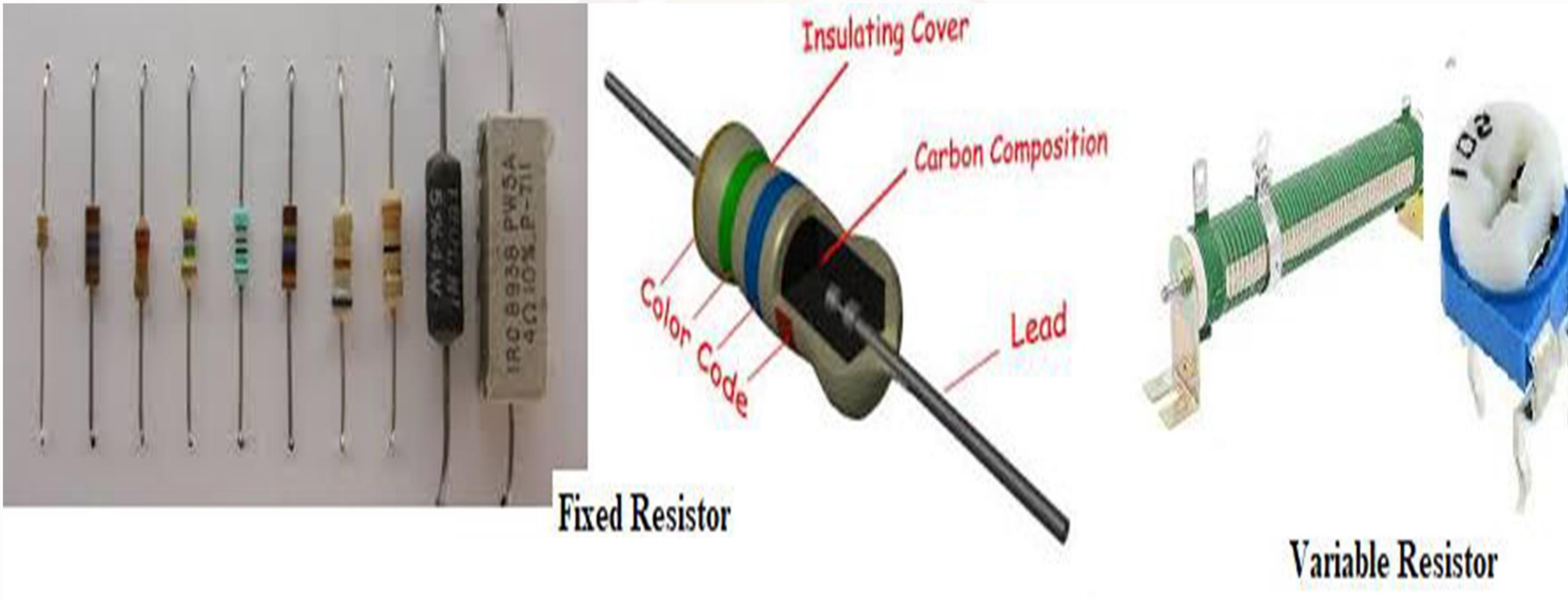
$$i = \frac{dq}{dt}$$

Common examples of passive components include:

- Resistors
- Inductors
- Capacitors
- Transformers

Resistors

A resistor is taken as a passive element since it can not deliver any energy to a circuit. Instead
resistors can only recieve energy which they can dissipate as heat as long as current flows
through it.


Insulating Cover
Carbon Composition
Color Code
Lead
Fixed Resistor
Variable Resistor

Inductors

An inductor is also considered as passive element of circuit, because it can store energy in it as a
magnetic field, and can deliver that energy to the circuit, but not in continuous basis. The energy
absorbing and delivering capacity of an inductor is limited and transient in nature. That is why an
inductor is taken as a passive element of a circuit.

Capacitors

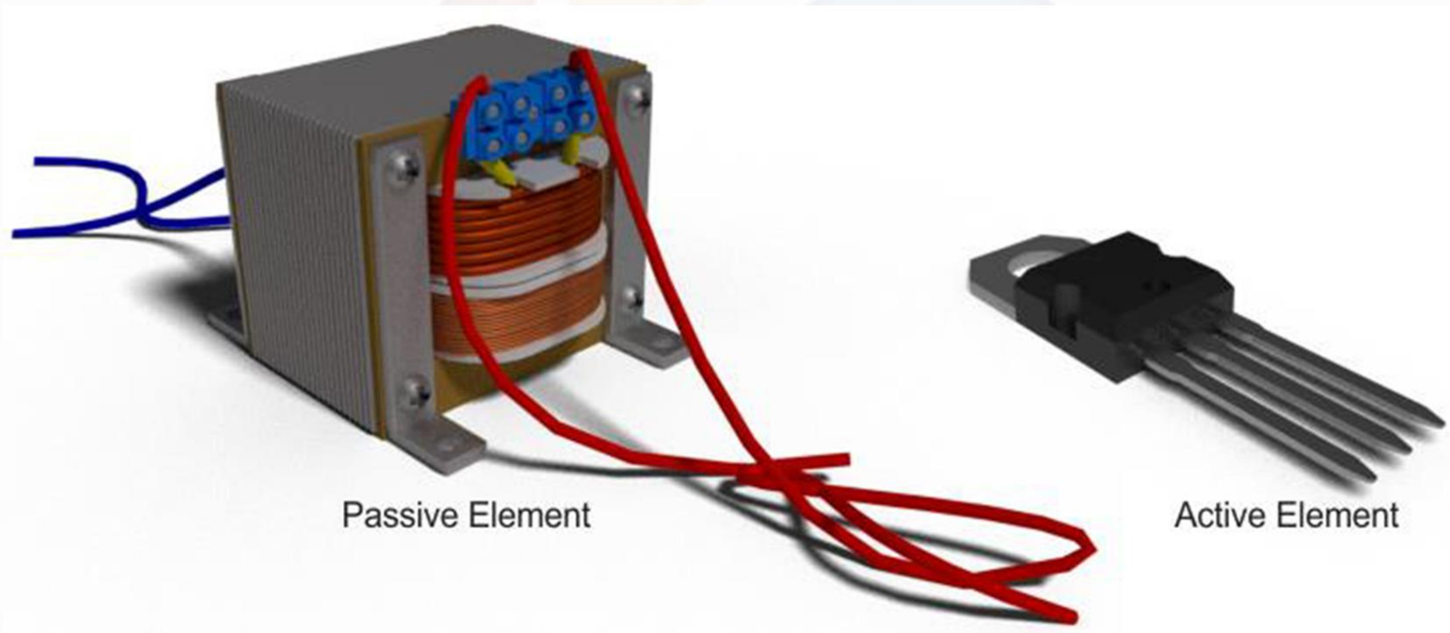
A capacitor is considered as a passive element because it can store energy in it as electric field.

The energy dealing capacity of a capacitor is limited and transient – it is not actually supplying
energy, it is storing it for later use.

As such it is not considered an active component since no energy is being supplied or amplified

Transformers

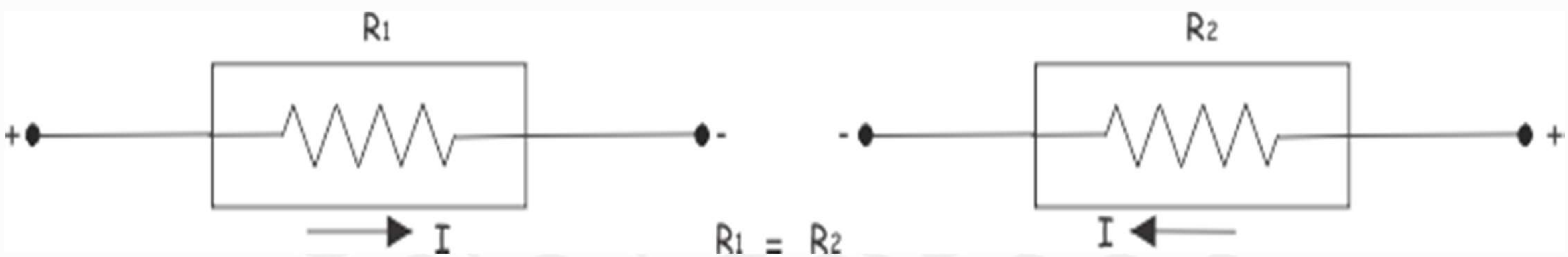
A transformer is also a passive electronic component. Although this can seem surprising since
transformers are often used to raise voltage levels – remember that power is kept constant.
When transformers step up (or step down) voltage, power and energy remain the same on the
primary and secondary side. As energy is not actually being amplified – a transformer is
classified as a passive element


Passive Element
Active Element

Bilateral Elements

Conduction of current in both directions in a circuit element with same magnitude is termed as a
bilateral circuit element. It offers some resistance to current flow in both directions.

Examples: Resistors, inductors, capacitors etc.

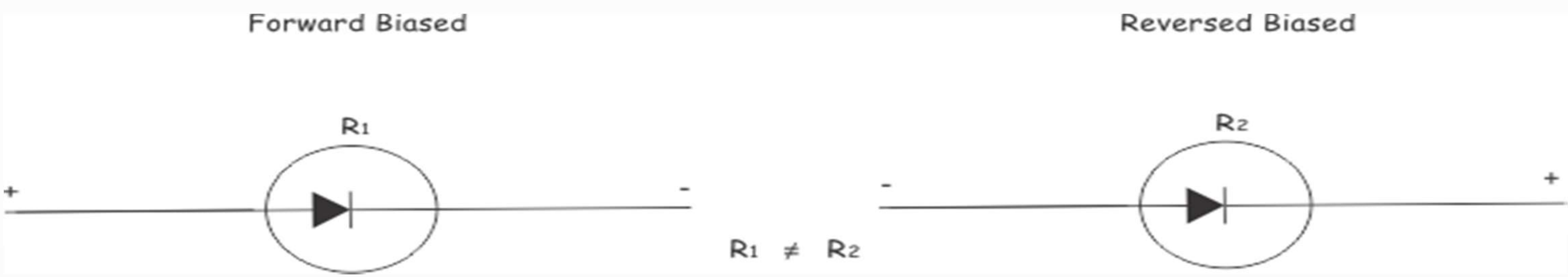


Unilateral Elements

The unilateral circuit element does not offer same resistance to the current of either direction.

The resistance of the unilateral circuit element is different for forward current than that of
reverse current.

Examples: diode, transistor etc.

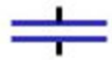
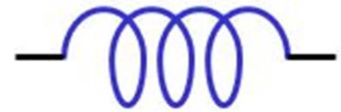


umped Elements

Vhen the voltage across and current through the element don't vary with dimensio
f the
lement, it is called lumped circuit elements.
xamples: Resistor connected in any electrical circuit

istributed Elements

Vhen the voltage across and current through the element change with dimensions
e element,
is called distributed circuit element.
xamples: Resistance of a transmission line. It varies with the length of the line

	Capacitor 	Resistor 	Inductor 
Series	$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$	$R = R_1 + R_2$	$L = L_1 + L_2$
Parallel	$C = C_1 + C_2$	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$	$\frac{1}{L} = \frac{1}{L_1} + \frac{1}{L_2}$
Fundamental Formula	$\Delta V = \frac{Q}{C}$	$\Delta V = IR$	$\text{E}_L = -L\frac{dI}{dt}$

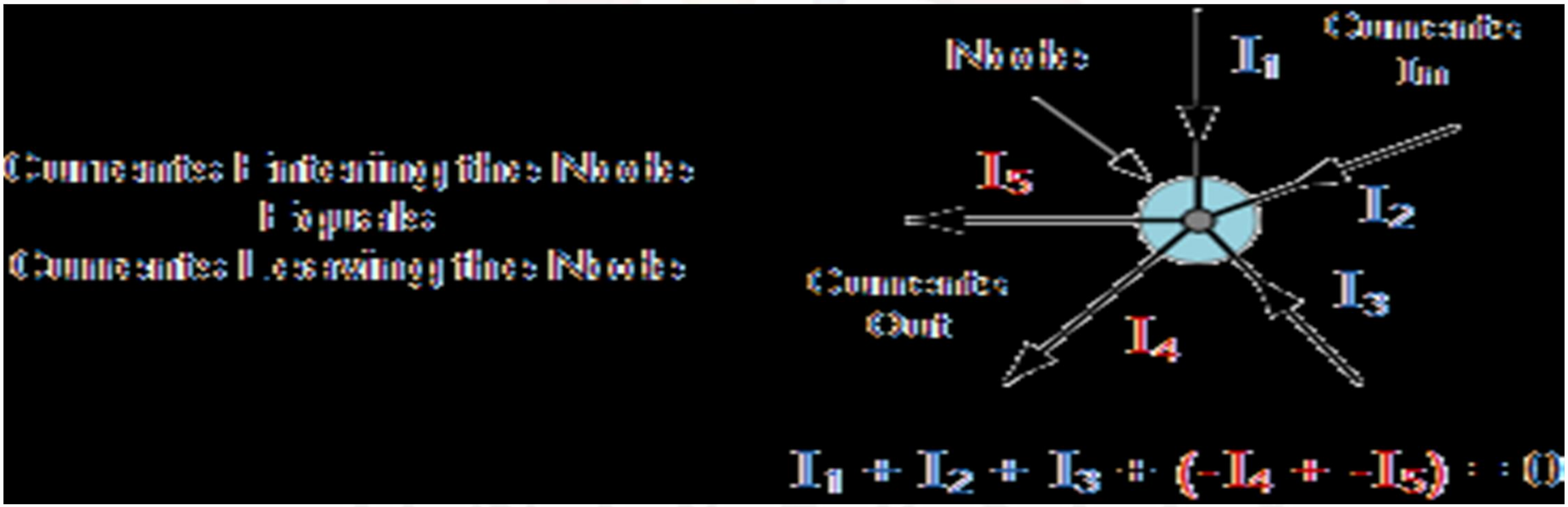
Kirchhoff's Law

In 1845, a German physicist, Gustav Kirchhoff developed a pair or set of rules or laws which
deal with the conservation of current and energy within electrical circuits. These two rules are
commonly known as: Kirchhoff's Circuit Laws with one of Kirchhoff's laws dealing with the
current flowing around a closed circuit, Kirchhoff's Current Law, (KCL) while the other law
deals with the voltage sources present in a closed circuit, Kirchhoff's Voltage Law, (KVL).

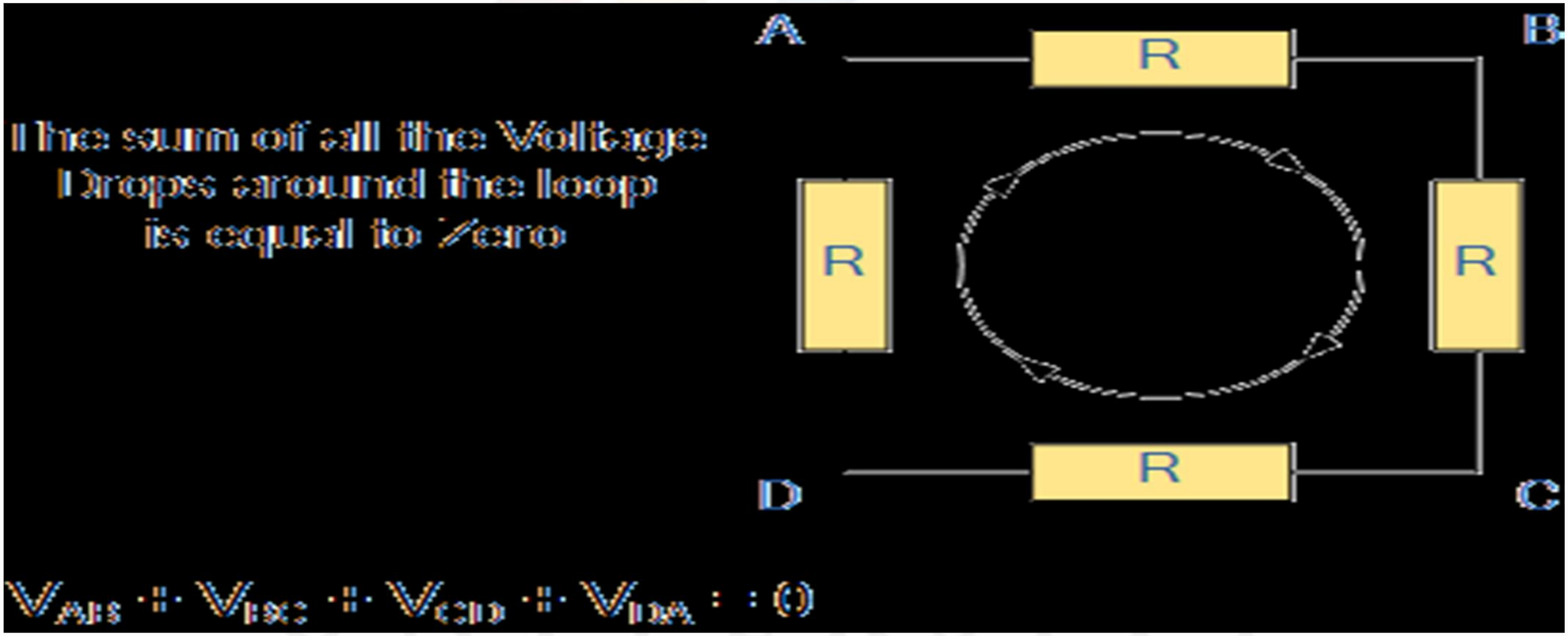
rchhoff's First Law – The Current Law, (KCL)

rchhoff's Current Law or KCL, states that the *"Algebraic sum of all current eeting at node zero* ". In other words the algebraic sum of ALL the currents entering the node equal to aving a node, I(exiting) = I(entering) . This idea by Kirchhoff is commonly known s e **Conservation of Charge**

Kirchhoffs Current Law



Here, the three currents entering the node, I1, I2, I3 are all positive in value and the two currents
leaving the node, I4 and I5 are negative in value. Then this means we can also rewrite the
equation as;
I1 + I2 + I3 – I4 – I5 = 0
Kirchhoffs Second Law – The Voltage Law, (KVL)
Kirchhoffs Voltage Law or KVL, states that "*in any network, the algebraic sum voltage around*
the loop is equal to zero". In other words the algebraic sum of all voltage rise is equal to
algebraic sum of all voltage drop within the loop. This idea by Kirchhoff is known as the **Conservation of Energy**.
Kirchhoffs Voltage Law


A
R
B
The sum of all the Voltage
Drops around the loop
is equal to Zero
R
R
D
R
C
VAB + VBC + VCD + VDA = 0