ELEMENT COMBINATION RULE

BASIC CIRCUIT ANALYSIS METHOD

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TOPIC OUTLINE

Ohm's Law

Series Network

Parallel Network

Series-Parallel Network

OHM'S LAW

OHM'S LAW

Ohm's Law states that the ratio of voltage (***V***) to current (***I***) is **constant** (***R***).

Mathematical representation

$$R = \frac{V}{I}$$

Basic Electrical Quantities

1. **Voltage** (**V**)

The measure of electrical potential energy per unit charge. It is the "**push**" or "force" that drives electric current through a circuit.

Formula

$$V = IR$$

unit: Volt (V)

OHM'S LAW

Ohm's Law states that the ratio of voltage (***V***) to current (***I***) is **constant** (***R***).

Mathematical representation

$$R = \frac{V}{I}$$

Basic Electrical Quantities

2. **Current** (**I**)

The **flow of electric charge**, typically carried by electrons in a conductor. It represents the rate at which charge flows through a point in a circuit.

Formula

$$I = \frac{V}{R}$$

unit: Ampere (A)

OHM'S LAW

Ohm's Law states that the ratio of voltage (***V***) to current (***I***) is **constant** (***R***).

Mathematical representation

$$R = \frac{V}{I}$$

Basic Electrical Quantities

3. **Resistance** (**R**)

The **opposition** to the flow of electric current in a material or component. It determines how much current will flow for a given voltage.

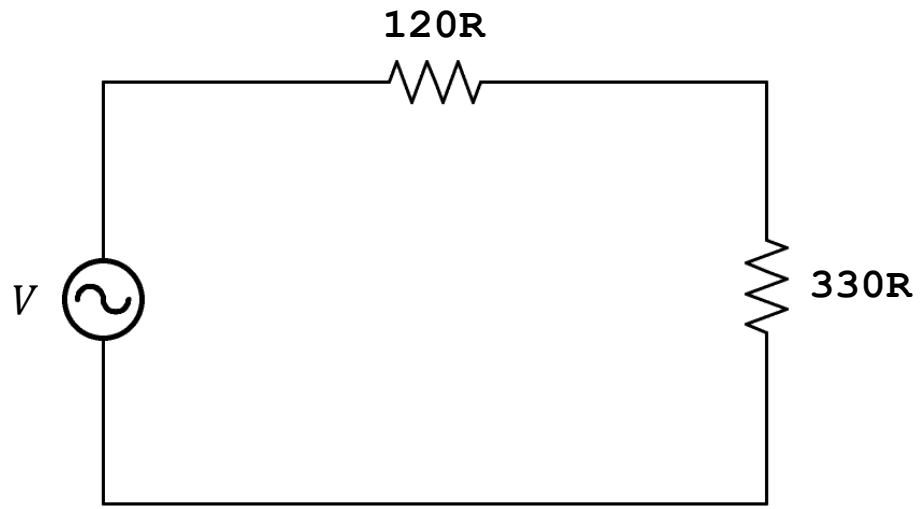
Formula

$$R = \frac{V}{I}$$

unit: Ohm (Ω)

EXERCISE

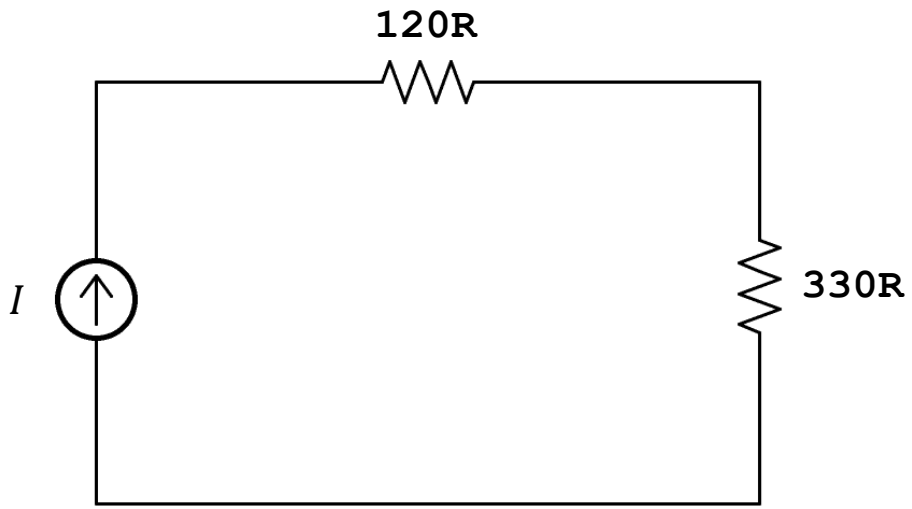
In the given circuit, the voltage drop across a 120Ω resistor is measured as 2.4V. Determine the current flowing through the resistors.



Solution

EXERCISE

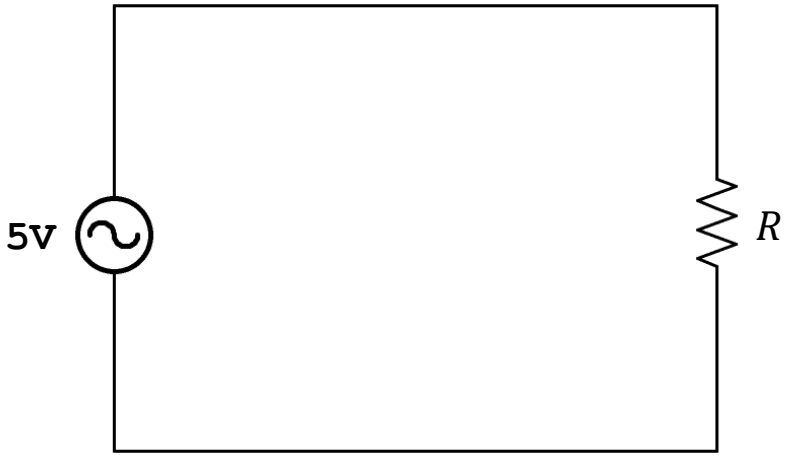
A 330 Ω resistor in the given circuit carries a current of 1mA. Calculate the voltage drop across the resistors.



Solution

EXERCISE

The given circuit has an applied voltage of 5V, resulting in a current flow of $5mA$. Determine the resistance of the circuit.



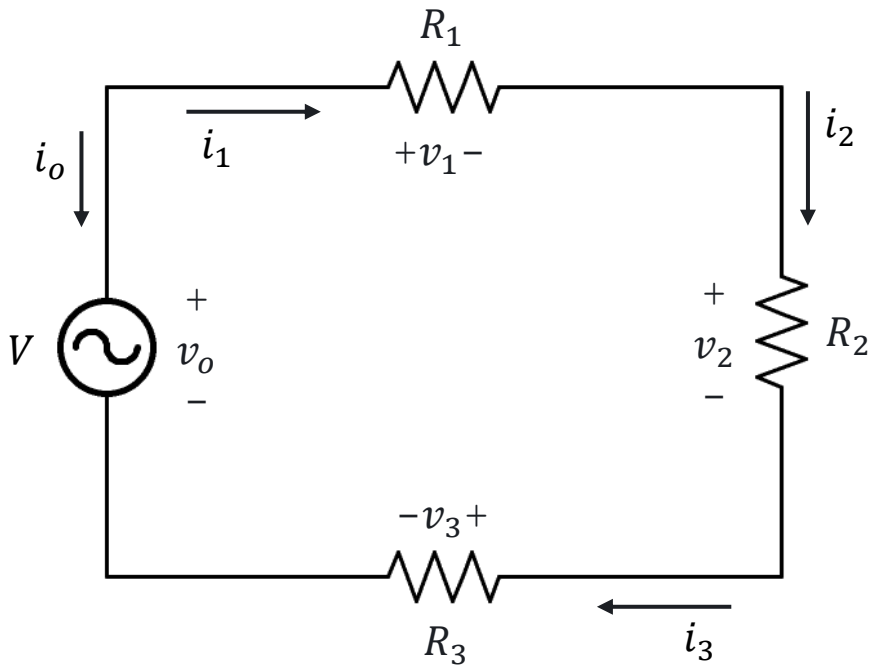
Solution

SERIES NETWORK

SERIES NETWORK

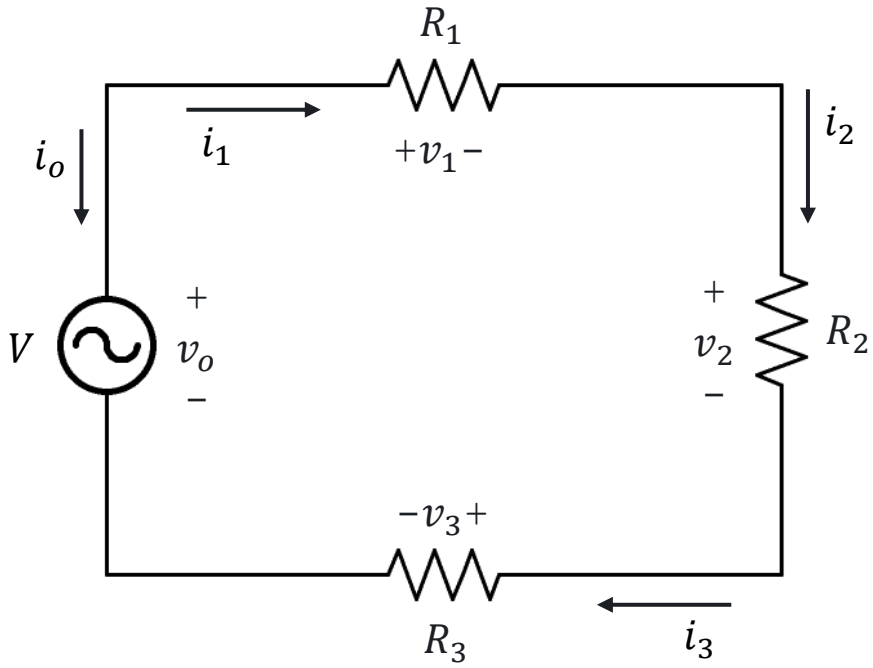
A **series network** refers to a configuration where components are connected end-to-end, forming a **single path** for current to flow.

Series Network



CURRENT

Series Network



In a series network, the **same current** flows through all components.

Mathematical representation

$$i_o = i_1 = i_2 = i_3 = \cdots i_n$$

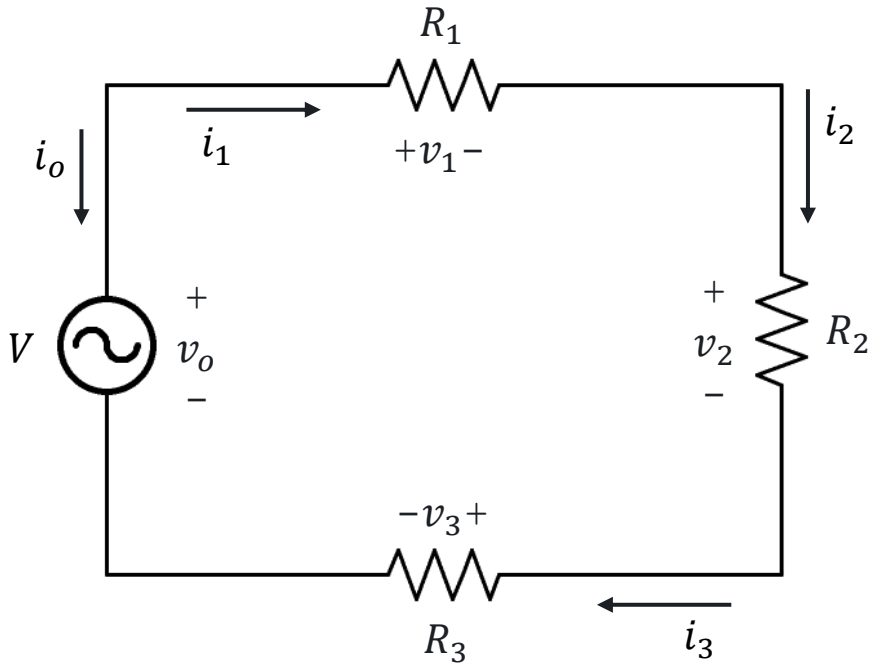
RESISTANCE

In a series network, the **total resistance** is the **sum** of the individual resistances.

Mathematical representation

$$R_o = R_1 + R_2 + R_3 + \cdots R_n$$

Series Network



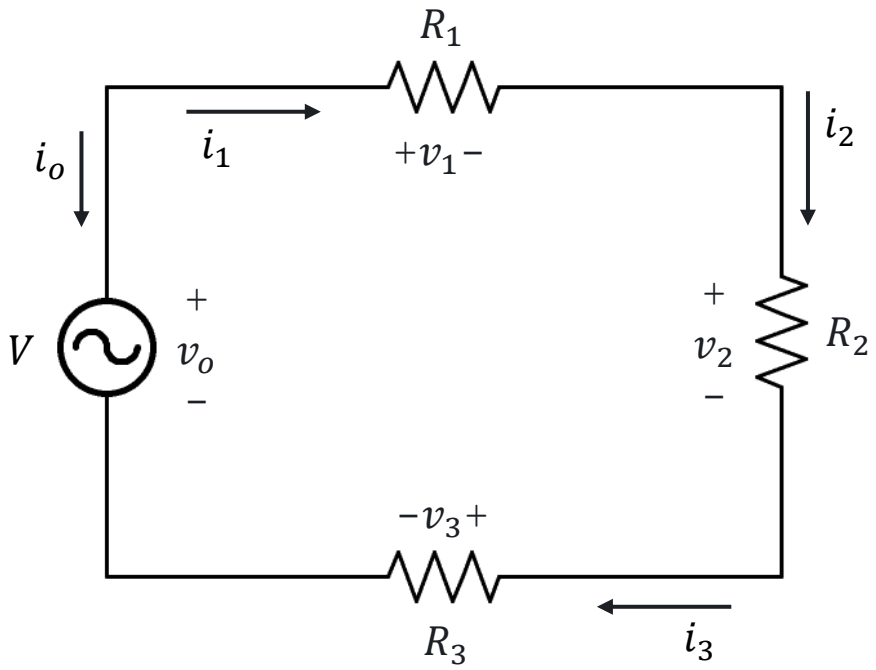
VOLTAGE

In a series network, the **total voltage** is the **sum** of the voltages across each individual component.

Mathematical representation

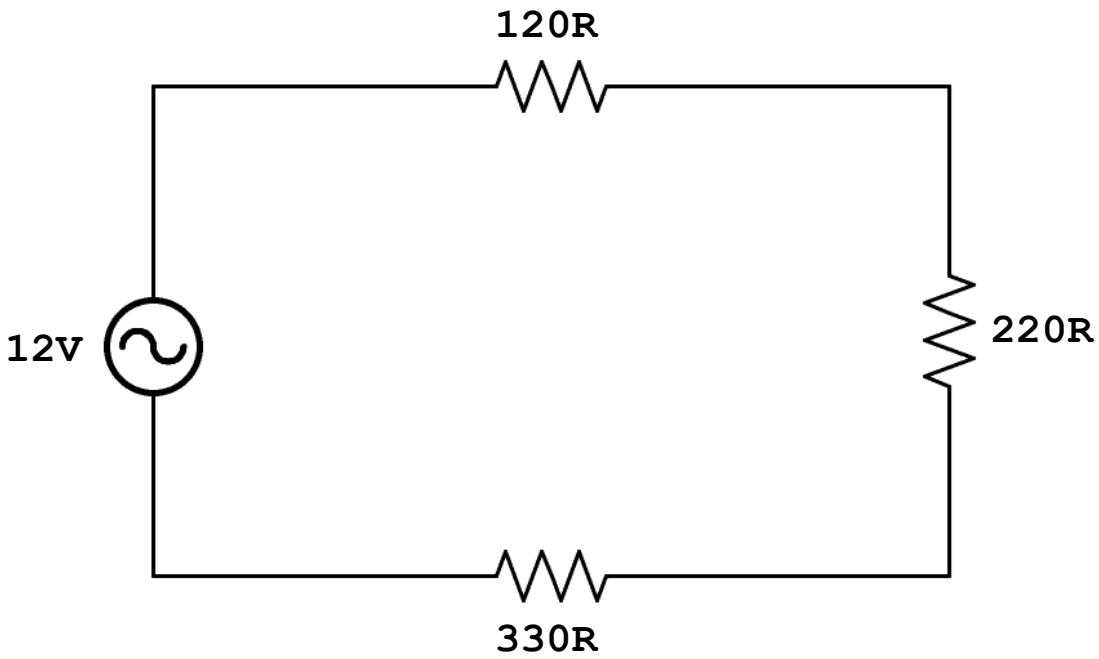
$$v_o = v_1 + v_2 + v_3 + \cdots v_n$$

Series Network



EXERCISE

For the given series circuit, determine the voltage drops across each individual resistor.

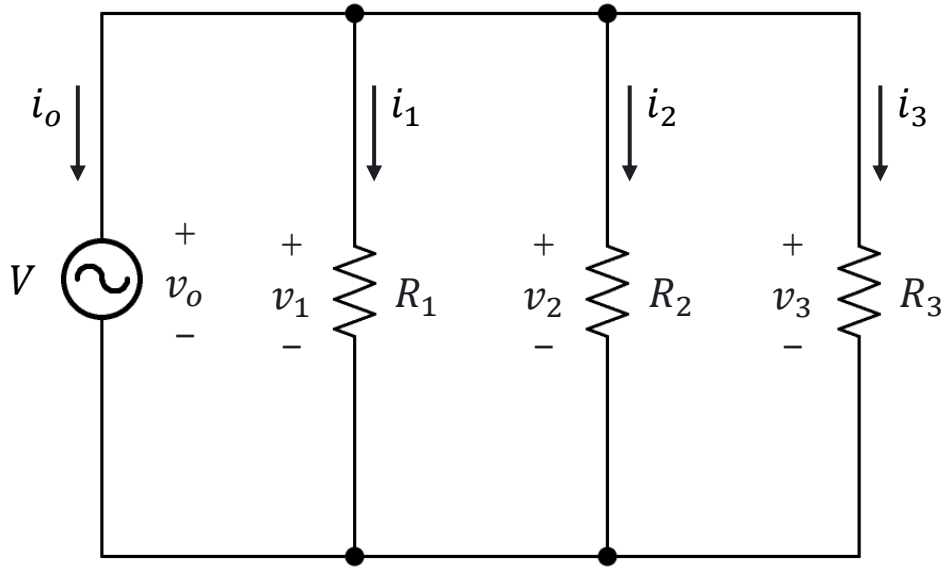


Solution

PARALLEL NETWORK

A **parallel network** is a configuration where components are connected across the same two points, providing **multiple paths** for current to flow.

Parallel Network



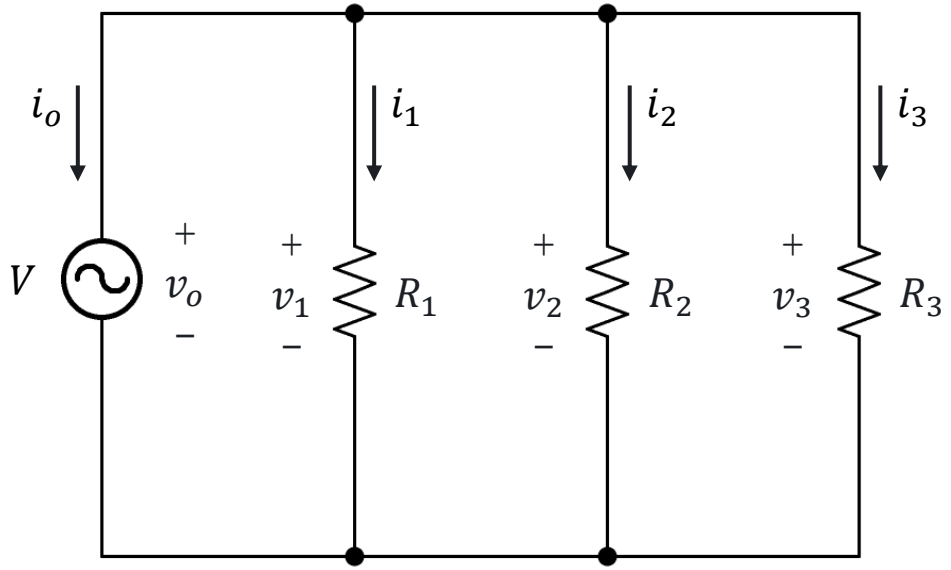
VOLTAGE

In a parallel network, the **voltage** is the **same** across all components.

Mathematical representation

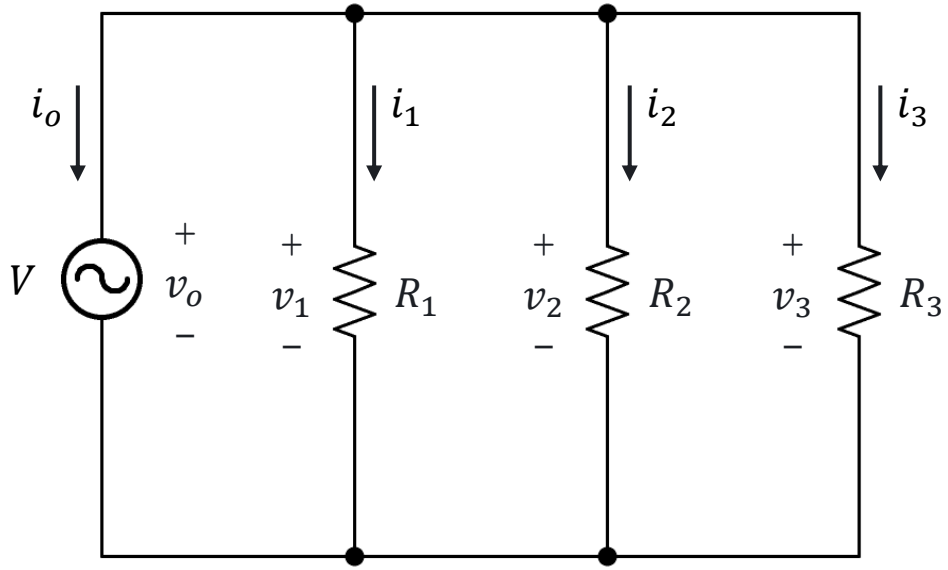
$$v_o = v_1 = v_2 = v_3 = \cdots v_n$$

Parallel Network



CONDUCTANCE

Parallel Network



Conductance refers to the ability of the network to allow the flow of electric current. It is the **reciprocal of resistance** and is measured in siemens (***S***).

Mathematical representation

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

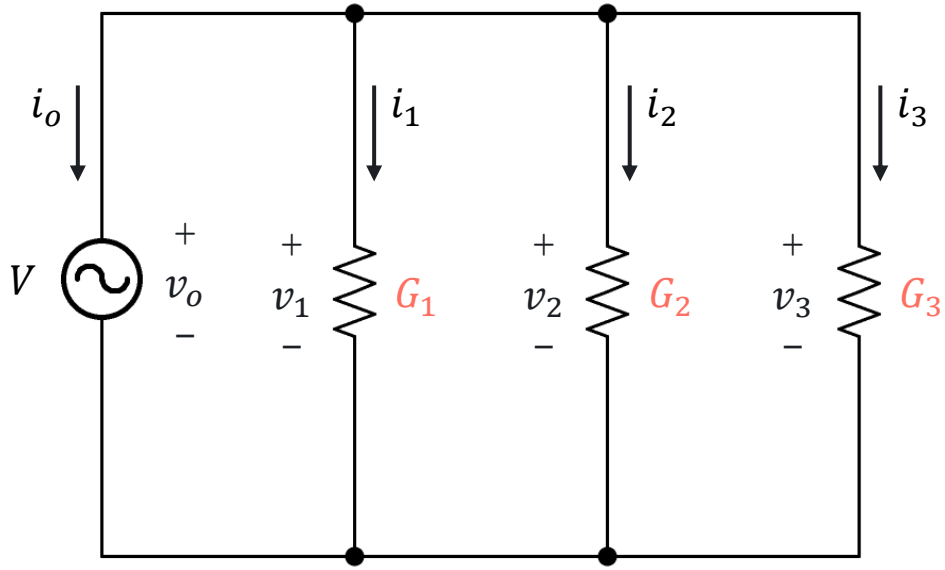
CONDUCTANCE

In a parallel network, the **total conductance** is the **sum** of the individual conductance of each resistor.

Mathematical representation

$$G_o = G_1 + G_2 + G_3 + \cdots G_n$$

Parallel Network



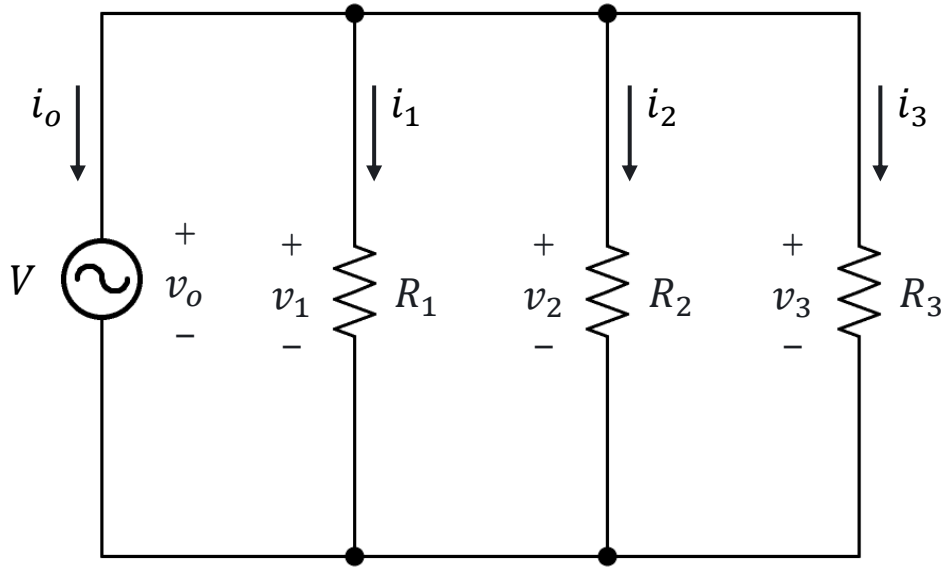
CURRENT

In a parallel network, the **total current** is the **sum** of the current flowing through each individual component.

Mathematical representation

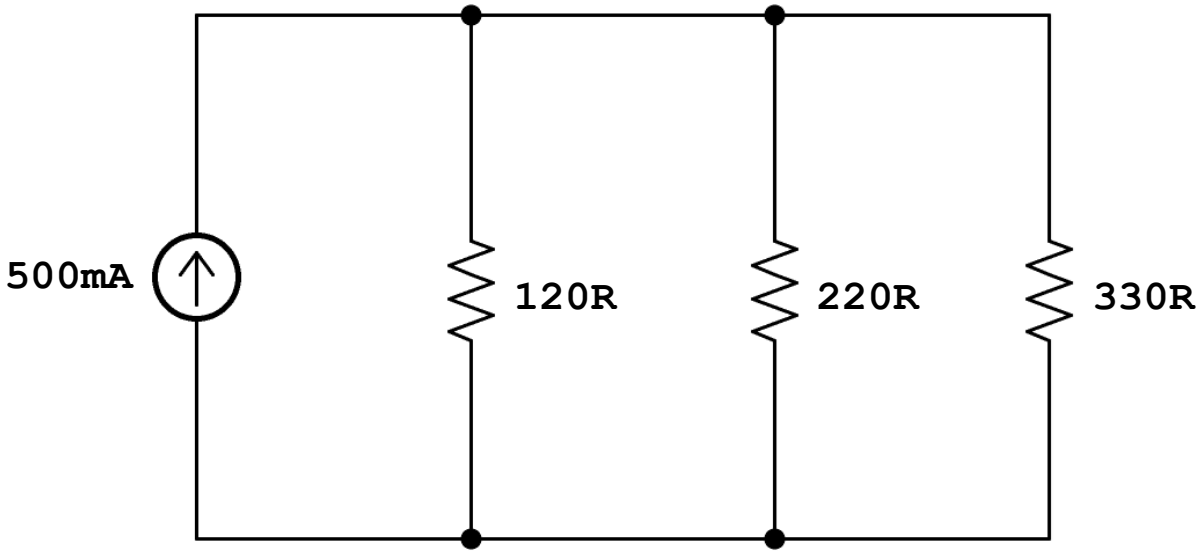
$$i_o = i_1 + i_2 + i_3 + \cdots i_n$$

Parallel Network



EXERCISE

For the given parallel circuit, determine the current flowing through each individual resistor.



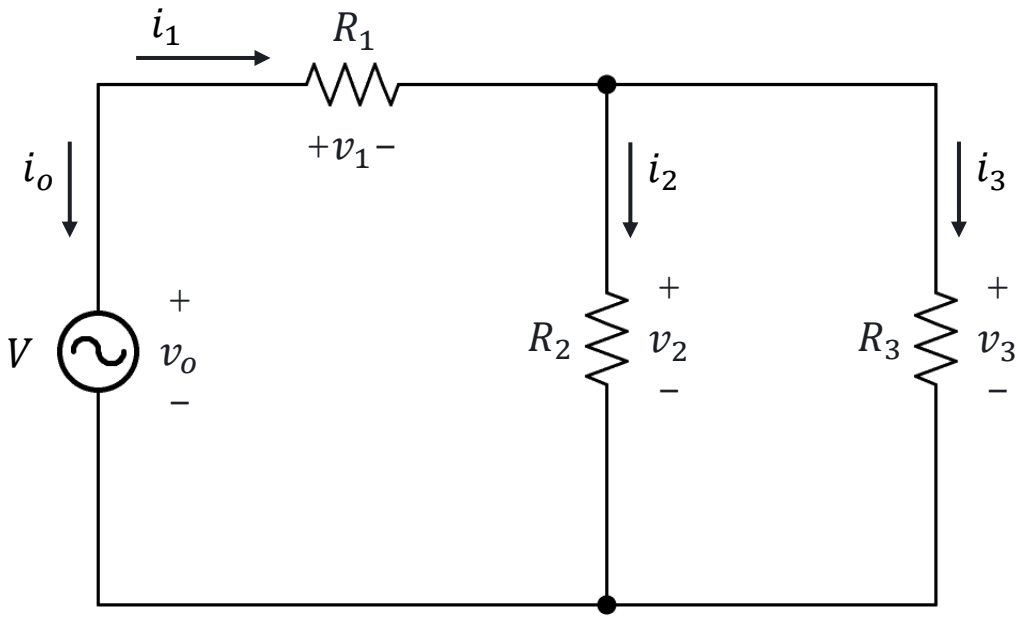
Solution

SERIES PARALLEL NETWORK

SERIEL-PARALLEL NETWORK

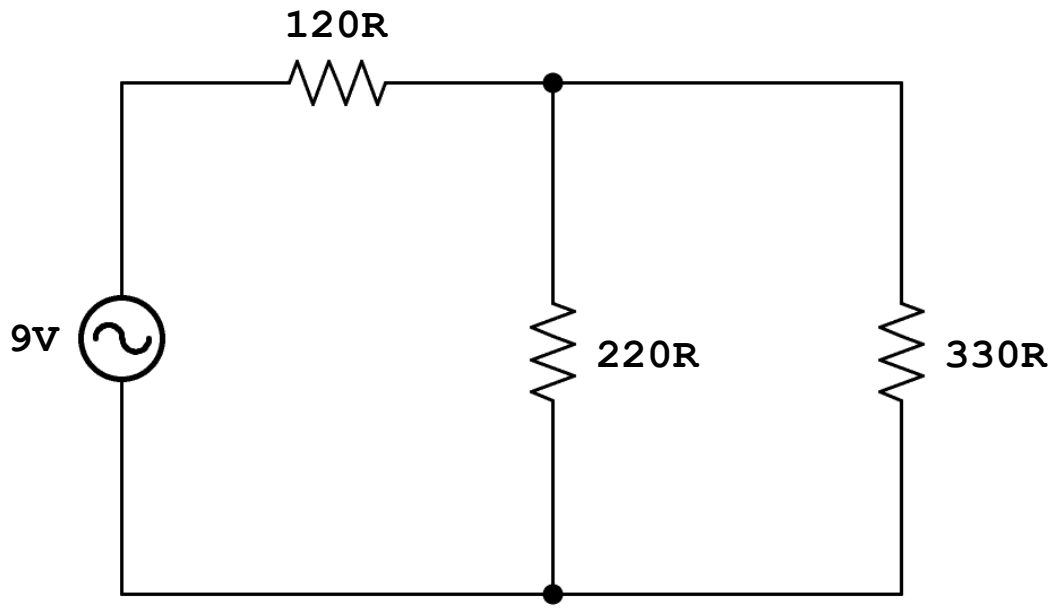
A **series-parallel** network is a type of electrical network that combines elements of both **series** and **parallel** circuits. These networks are commonly used in electrical and electronic systems to achieve desired voltage, current, and resistance characteristics.

Series-Parallel Network



EXERCISE

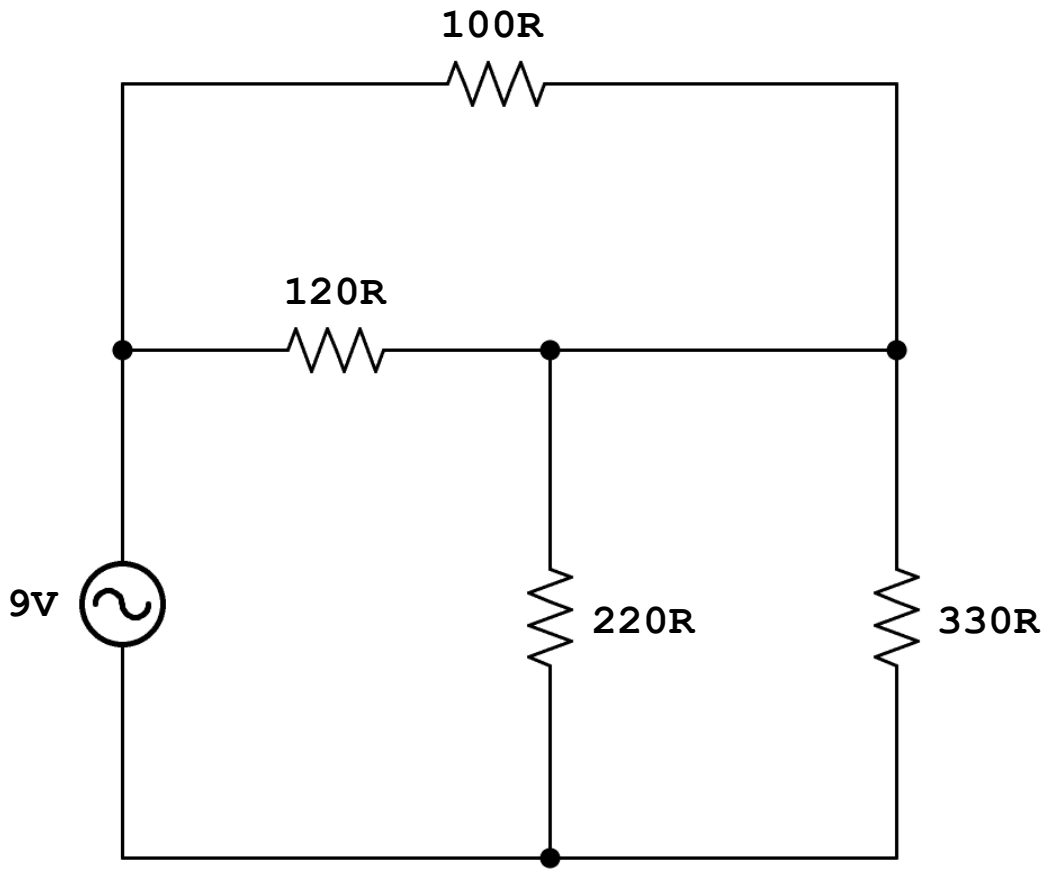
Analyze the given circuit to determine both the current through and the voltage drop across each resistor.



Solution

EXERCISE

Analyze the given circuit to determine both the current through and the voltage drop across each resistor.



Solution

EXERCISE

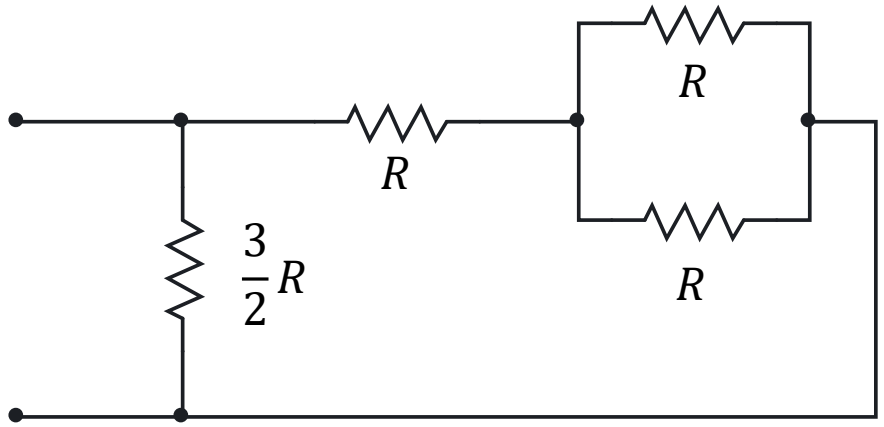
Using only $1K$ resistors, synthesize a resistor of $3/5K$ and $5/3K$. Use no more than four 1K resistors.

Solution

EXERCISE

Find the equivalent resistance of the given network as viewed from its port.

Solution



EXERCISE

You are given a black box with three terminals, as shown in Fig.1. The box is known to contain five 1-ohm resistors.

Using an ohm-meter, you measure the resistance between terminals to be the following:

A−B: 1.5 ohms

B−C: 3 ohms

A−C: 2.5 ohms

Determine the configuration of the five resistors inside the box.

Solution

Fig.1. Black box

LABORATORY