LAB 6
Series and Parallel Resistors

OBJECTIVES

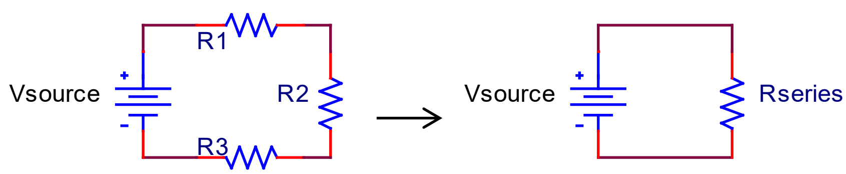
1. Practice building circuits from circuit diagrams.
2. Predict and correctly measure the voltages, currents, and resistances of series & parallel circuits.

EQUIPMENT

Power supply, digital multimeters, breadboard, resistors (120 Ω, 240 Ω, and 560 Ω), and leads.

THEORY

In a series circuit,

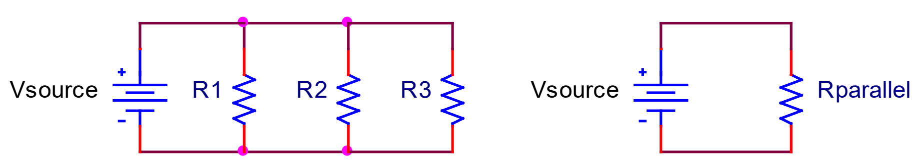


the equivalent series resistance R_{series} is the sum of the individual resistances: $R_{series} = \sum R_n$

Key properties of a series circuit are (1) the current through all elements is the same and (2) the voltages across all elements must added up to the source voltage, according to Kirchhoff's Voltage Law (KVL)

$$\sum V_n = 0 \quad \Rightarrow \quad V_{source} = V_1 + V_2 + V_3$$

In a parallel circuit,



the equivalent parallel resistance $R_{parallel}$ is given by: $\frac{1}{R_{parallel}} = \sum \frac{1}{R_n}$

Key properties of a parallel circuit are (1) the voltage across all elements is the same and (2) the currents through all elements must add up to the source current, according to Kirchhoff's Current Law (KCL):

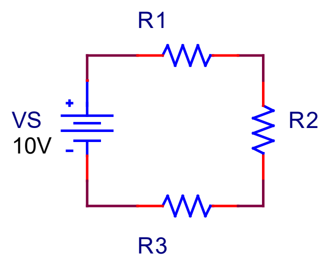
$$\sum i_n = 0 \quad \Rightarrow \quad i_{source} = i_1 + i_2 + \cdots + i_n$$

PROCEDURE

Part 1: Basic Series Measurements

Part 1A: Equivalent Series Resistance

Construct the following series circuit but **do not** turn on the power supply.



a) **Measure** the actual values of each of your three resistors using the DMM.
b) **Predict** the theoretical equivalent resistance, R_{thy}, using the *measured* resistor values.
c) **Measure** the total resistance, R_{expt}, of the three resistors using the DMM. *Do not turn on the power supply for this step.*
d) **Compare** the predicted and the measured equivalent resistance using a percent difference. *How do they compare? How does the equivalent series resistance compare with that of the individual resistor values? Why?*

Part 1B: Properties of a Series Circuit

Series Voltage

a) Turn on the power supply and set the voltage to 10.0 V using the DMM.
b) **Measure** the voltage across each resistor. *Record your values in table.*
c) **Verify** that Kirchhoff's Voltage law is satisfied around the path ($V_S = V_1 + V_2 + V_3$). *From your data table is there a relationship between the resistor value and the voltage drop across the resistor? Explain your reasoning.*

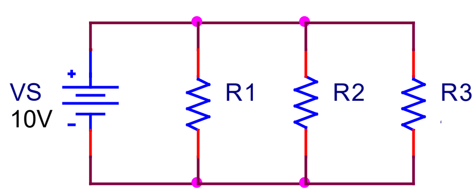
Series Current

d) **Predict** the currents $(i_1, i_2, i_3)_{thy}$ through each resistor using the measured voltages across each resistor and the measured resistor value.
e) **Measure** the current *before* each of the three resistors by inserting the DMM in series with each resistor. *Record your values.*
f) **Compare** the three currents – what can you deduce about the current in a series circuit? *Explain your reasoning.*

Part 2 Basic Parallel Measurements

Part 2A: Equivalent Parallel Resistance

Construct the following parallel circuit but **do not** turn on the power supply.



a) **Predict** the equivalent resistance using the *measured* resistor values; $(R_{parallel})_{thy}$.
b) **Measure** the total resistance using a DMM; $(R_{parallel})_{expt}$. *Do not turn on the power supply for this step.*
c) **Compare** the predicted and the measured equivalent resistance using a percent difference. *How do they compare? How does the equivalent parallel resistance compare with that of the individual resistor values? Why?*

Part 2B: Properties of a Parallel Circuit

Parallel Currents

a) **Measure** the current through each resistor with the DMM. Record your values in table.
b) **Verify** that Kirchhoff's Current law is satisfied ($i_S = i_1 + i_2 + i_3$). From your data table, is there a relationship between the resistor value and the current through each resistor? *Explain your reasoning.*

Parallel Voltages

c) **Predict** the voltages $(V_1, V_2, V_3)_{thy}$ across each resistor using the measured currents through each resistor and the measured resistor value.
d) **Measure** the voltage across each of the three resistors using a DMM. *Record your values.*
e) **Compare** the three voltages – what can you deduce about the voltage in a parallel circuit? *Explain your reasoning.*

Part 3: Series and Parallel Combination Circuits

a) **Design** a circuit that has two resistors (120 Ω and 240 Ω) in series in parallel with a third resistor (560 Ω) Connect the combination of resistors to the power supply set at 10.0 V.
b) **Predict** the voltage across and the current through each of the three resistors. *Record your predictions in a table.*
c) **Measure** the voltage across and the current through each resistor using a DMM. *Record your measurements in a table. How do they compare with your predictions?*

d) **Design** a circuit that has two resistors (120 Ω and 240 Ω) in parallel in series with a third resistor (560 Ω). Connect the combination of resistors to the power supply set at 10.0 V.
e) **Predict** the voltage across and the current through each of the three resistors. *Record your predictions in a table.*
f) **Measure** the voltage across and the current through each resistor using a DMM. *Record your measurements in a table. How do they compare with your predictions?*