VOLTAGE AND CURRENT DIVIDER THEOREM

BASIC CIRCUIT ANALYSIS METHOD

prepared by:

Gyro A. Madrona
Electronics Engineer

TOPIC OUTLINE

Voltage Divider Theorem (VDT)

Current Divider Theorem (IDT)

VOLTAGE DIVIDER THEOREM

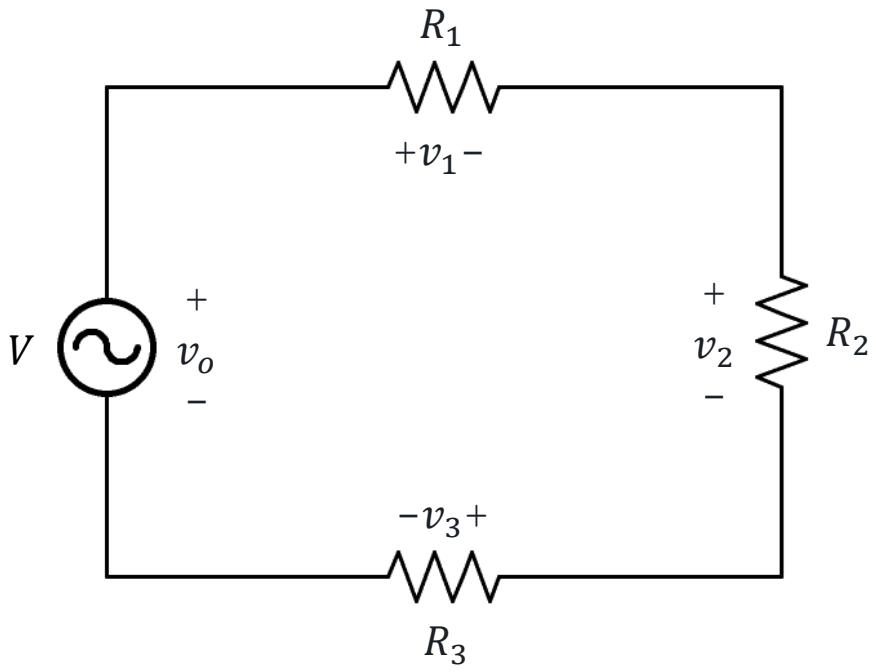
VOLTAGE DIVIDER THEOREM

In a series circuit consisting of multiple resistors, the **voltage** across any resistor is **proportional** to its resistance relative to the equivalent resistance of the series combination.

Formula

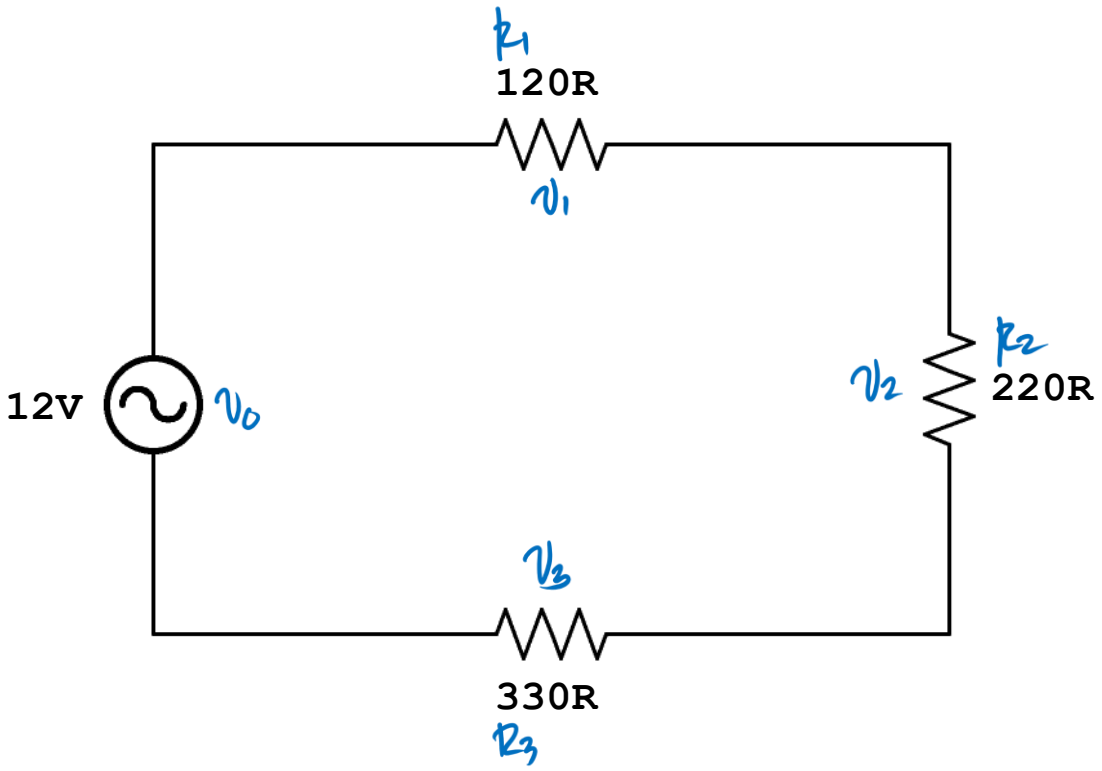
$$v_N = v_{in}\frac{R_N}{R_{eq}}$$

Series Network



EXERCISE

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



Solution

Total Resistance

$R_0 = R_1 + R_2 + R_3$

$R_0 = 120 + 220 + 330$

$R_0 = 670\,\Omega$

VDT

$V_1 = V_0 \frac{R_1}{R_0}$ $\quad V_2 = V_0 \frac{R_2}{R_0}$ $\quad V_3 = V_0 \frac{R_3}{R_0}$

$V_1 = 12 \frac{120}{670}$ $\quad V_2 = 12 \frac{220}{670}$ $\quad V_3 = 12 \frac{330}{670}$

$V_1 = 2.15\,V$ ans $\quad V_2 = 3.94\,V$ ans $\quad V_3 = 5.91\,V$ ans

$V_0 = 2.15 + 3.94 + 5.91 = 12V$ ✓

CURRENT DIVIDER THEOREM

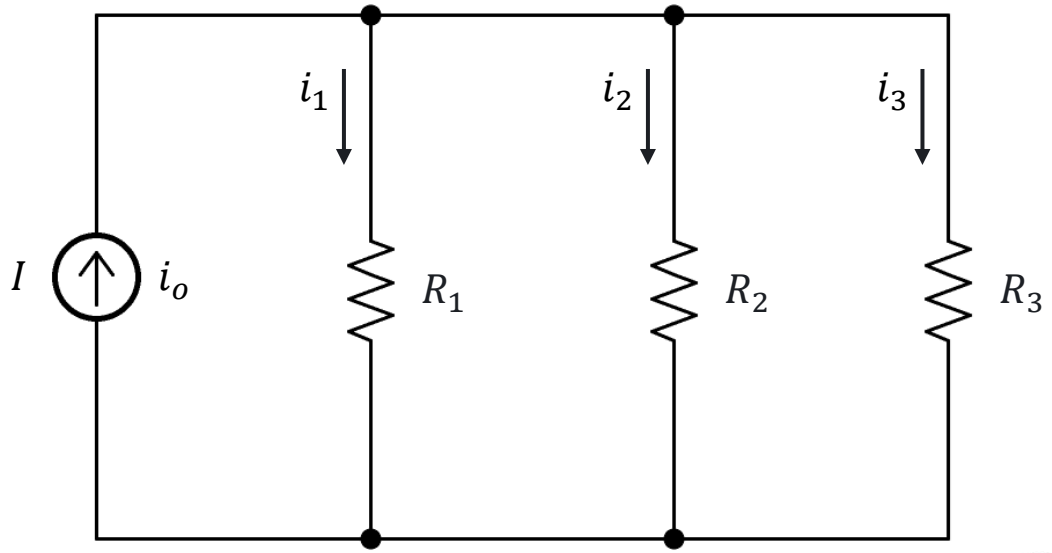
CURRENT DIVIDER THEOREM

In a parallel circuit with multiple resistors, the **current** through any resistor is **inversely** proportional to its resistance relative to the equivalent resistance of the parallel combination.

Formula

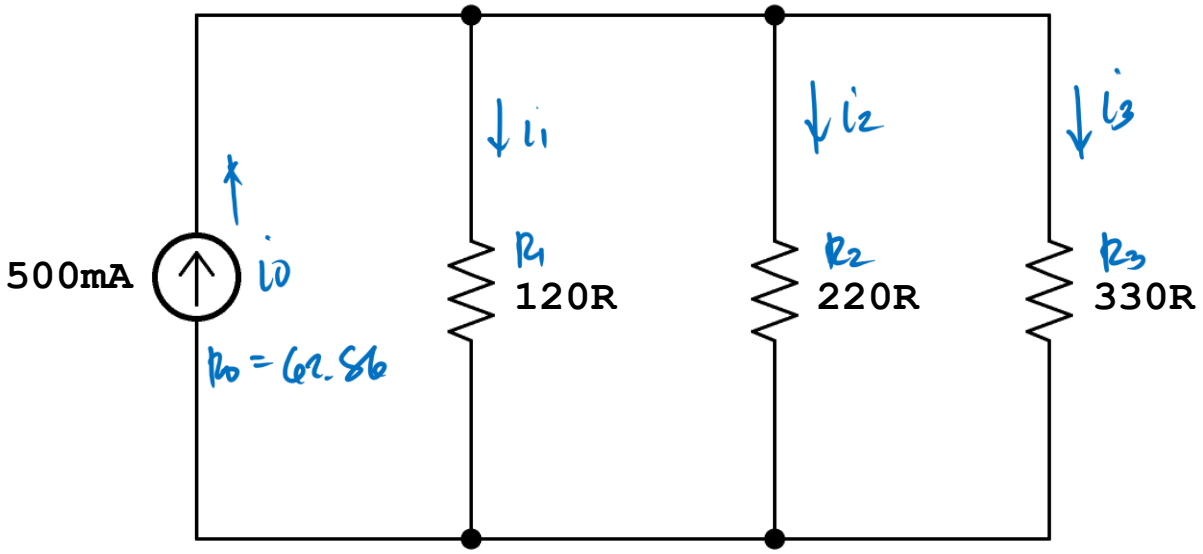
$$i_N = i_{in}\frac{R_{eq}}{R_N}$$

Parallel Network



EXERCISE

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



Solution

Total Resistance

$$G_0 = G_1 + G_2 + G_3$$

$$\frac{1}{R_0} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_0} = \frac{1}{120} + \frac{1}{220} + \frac{1}{330}$$

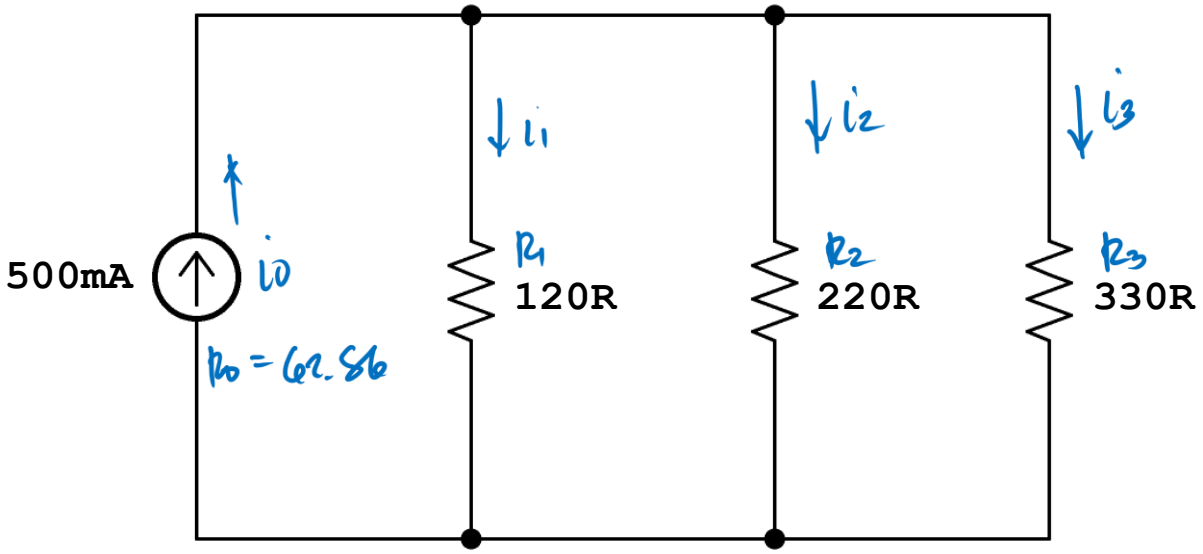
$$\frac{1}{R_0} = \frac{7}{440}$$

$$R_0 = \frac{440}{7}$$

$$R_0 = 62.86\,\Omega$$

EXERCISE

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



$i_o = 261.92 + 146.86 + 95.24$

$i_o = 500.02\ mA$ ✓

Solution

KCL

$$i_1 = i_o \frac{R_o}{R_1}$$

$$= 500m \frac{62.86}{120}$$

$$i_1 = 261.92\ mA$$ ans

$$i_3 = i_o \frac{R_o}{R_3}$$

$$= 500m \frac{62.86}{330}$$

$$i_3 = 95.24\ mA$$ ans

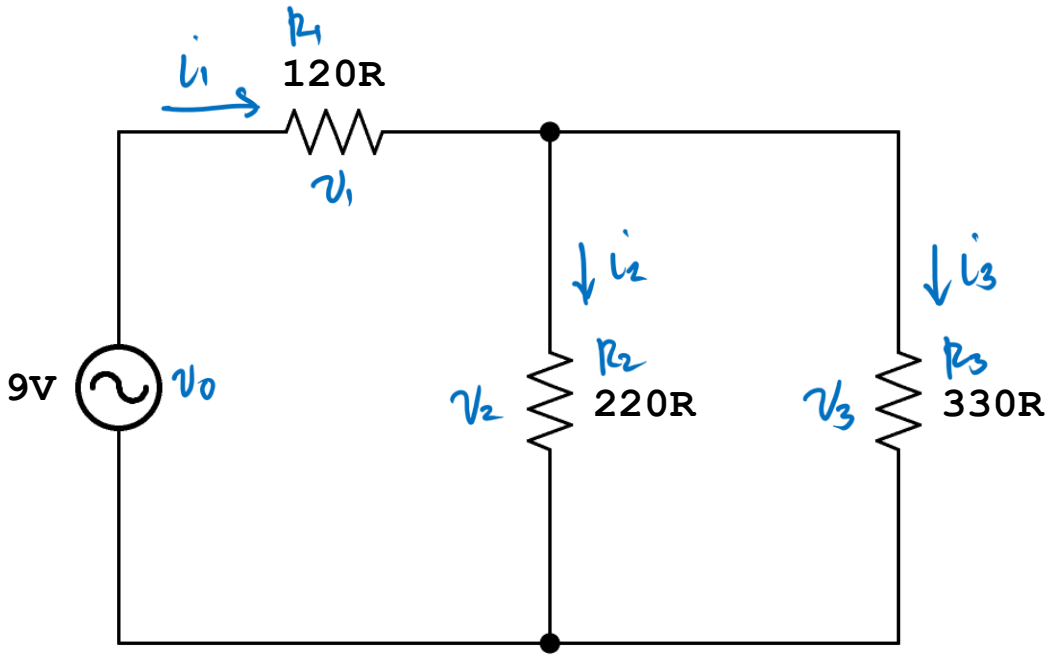
$$i_2 = i_o \frac{R_o}{R_2}$$

$$= 500m \frac{62.86}{220}$$

$$i_2 = 142.86\ mA$$ ans

EXERCISE

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



Solution

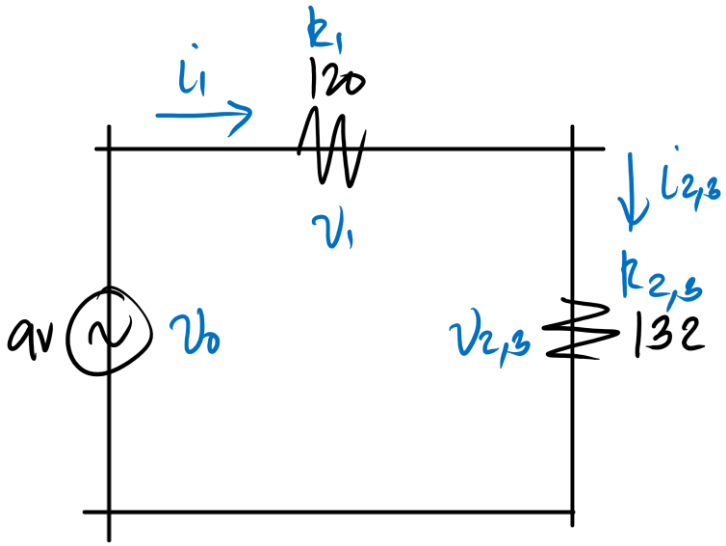
$$G_{2,3} = G_2 + G_3$$

$$\frac{1}{R_{2,3}} = \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_{2,3}} = \frac{1}{220} + \frac{1}{330}$$

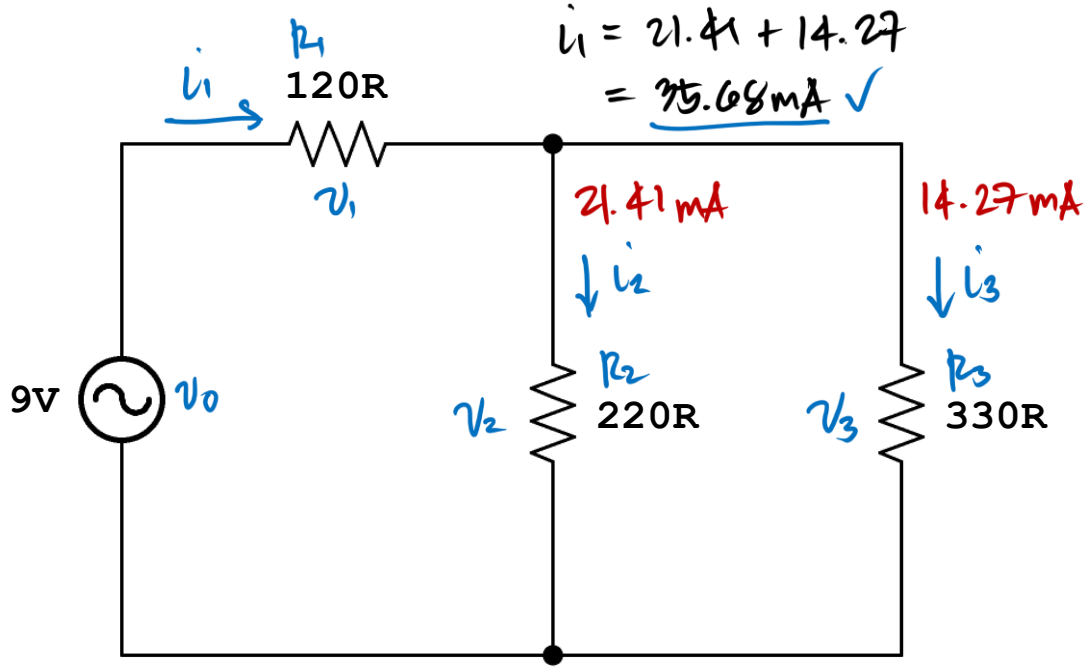
$$\frac{1}{R_{2,3}} = \frac{1}{132}$$

$$R_{2,3} = 132\,\Omega$$



EXERCISE

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



$i_1 = 21.41 + 14.27$

$= 35.68\,mA$ ✓

Solution

VDT

$$v_1 = v_0 \frac{R_1}{R_0}$$

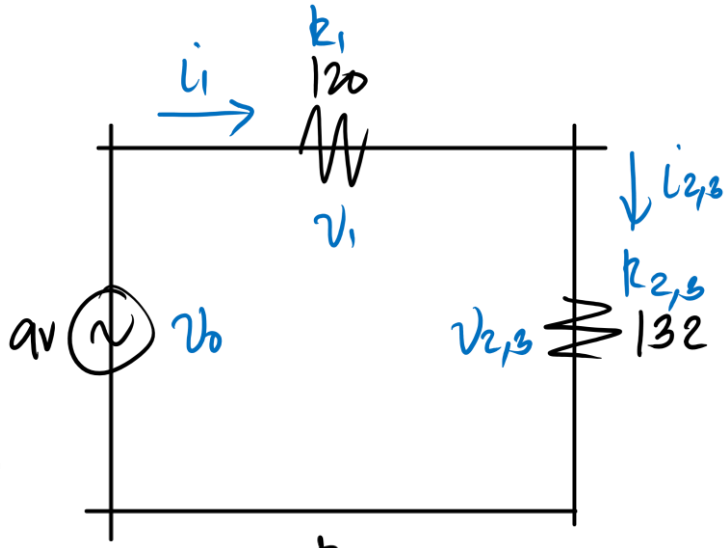
$$v_1 = 9 \frac{120}{120 + 132}$$

$$\boxed{v_1 = 4.29\ V}$$ ans

$$i_1 = \frac{v_1}{R_1}$$

$$= \frac{4.29}{120}$$

$$i_1 = 35.75\,mA$$



$$v_{2,3} = v_0 \frac{R_{2,3}}{R_0}$$

$$= 9 \frac{132}{120 + 132}$$

$$\boxed{v_2 = 4.71\ V}$$ ans

$$\boxed{v_3 = 4.71\ V}$$ ans

LABORATORY