
Resistors in Series and Parallel

EE 206 Circuits I

Jake Glower - Lecture #3

Please visit [Bison Academy](#) for corresponding
lecture notes, homework sets, and solutions

Resistors in Series:

Problem: Find the net resistance of this circuit:

Using Kirchoff's voltage law:

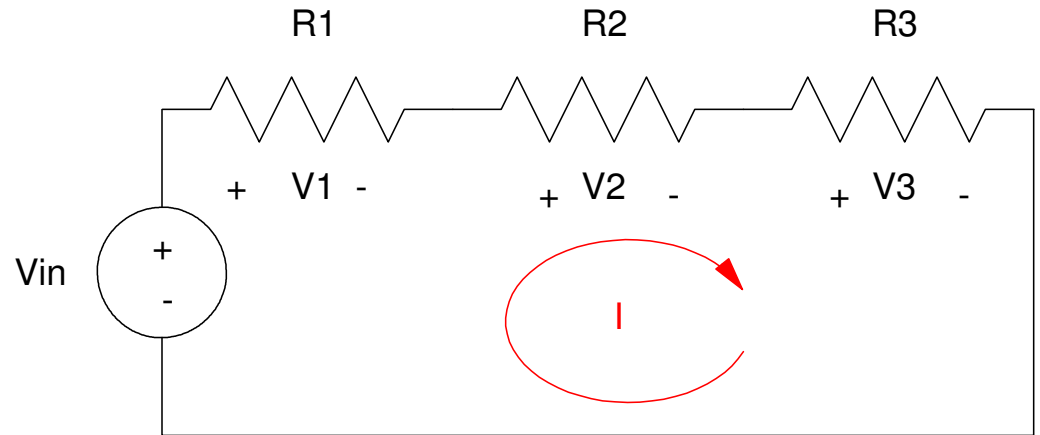
$$V_{in} = V_1 + V_2 + V_3$$

$$V_{in} = I \cdot R_1 + I \cdot R_2 + I \cdot R_3$$

$$V_{in} = I \cdot (R_1 + R_2 + R_3)$$

$$V_{in} = I \cdot R$$

Resistors in series add



Examples:

Let $R_1 = 100$ Ohms, $R_2 = 200$ Ohms, $R_3 = 300$ Ohms. Find the total resistance.

$$R_{net} = R_1 + R_2 + R_3$$

$$R_{net} = 100\Omega + 200\Omega + 300\Omega$$

$$R_{net} = 600\Omega$$

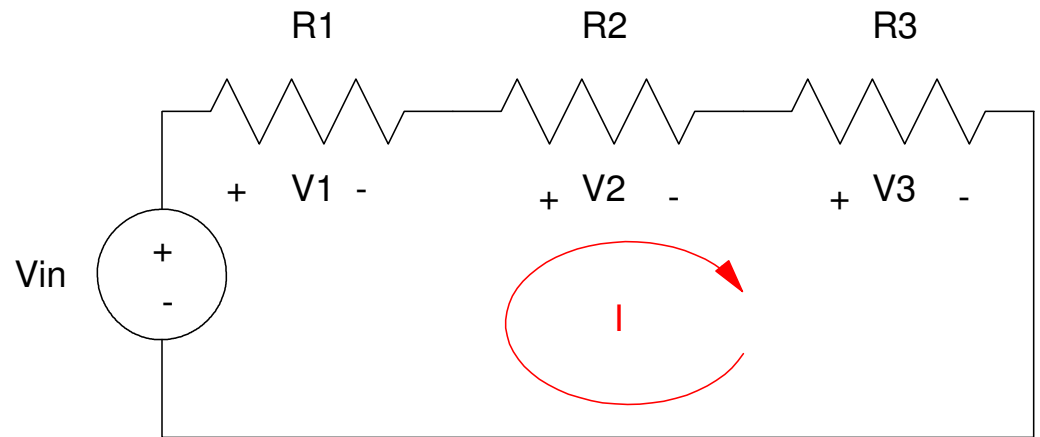
Let $R_1 = 100$ Ohms, $R_2 = 200$ Ohms,
 $R_{net} = 1000$ Ohms. Find R_3 .

Answer: Resistors in series add:

$$R_{net} = R_1 + R_2 + R_3$$

$$1000\Omega = 100\Omega + 200\Omega + R_3$$

$$R_3 = 700\Omega$$



Resistors in Parallel:

Find the net resistance:

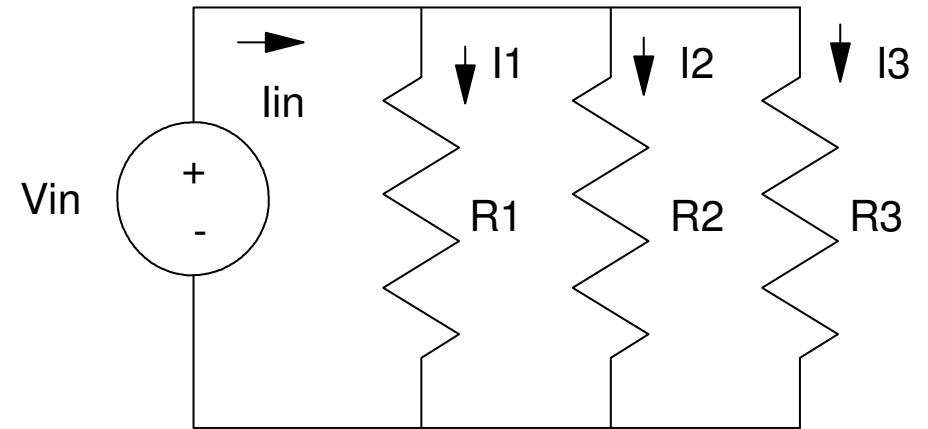
$$I_{in} = I_1 + I_2 + I_3$$

$$I_{in} = \left(\frac{V_{in}}{R_1}\right) + \left(\frac{V_{in}}{R_2}\right) + \left(\frac{V_{in}}{R_3}\right)$$

$$I_{in} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right) V_{in}$$

$$V_{in} = I_{in} \cdot \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)^{-1}$$

$$V_{in} = I_{in} \cdot R$$



In general:

$$R_{net} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots\right)^{-1}$$

Examples:

Let $R_1 = 100 \text{ Ohms}$, $R_2 = 200 \text{ Ohms}$, $R_3 = 300 \text{ Ohms}$. Find the total resistance.

$$R_{net} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \right)^{-1}$$

$$R_{net} = \left(\frac{1}{100} + \frac{1}{200} + \frac{1}{300} \right)^{-1}$$

$$R_{net} = 54.54 \Omega$$

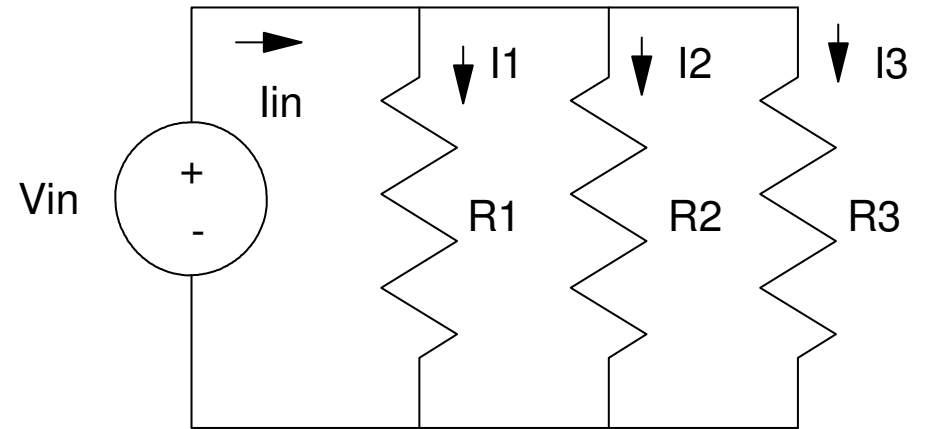
Let $R_2 = 200 \text{ Ohms}$, $R_3 = 300 \text{ Ohms}$,
 $R_{net} = 100 \text{ Ohms}$. Find R_1 .

$$R_{net} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \right)^{-1}$$

$$100 \Omega = \left(\frac{1}{R_1} + \frac{1}{200} + \frac{1}{300} \right)^{-1}$$

$$\frac{1}{100} = \frac{1}{R_1} + \frac{1}{200} + \frac{1}{300}$$

$$R_1 = 600 \Omega$$



Simplifying Circuits:

- Find the resistance seen by the 12V source

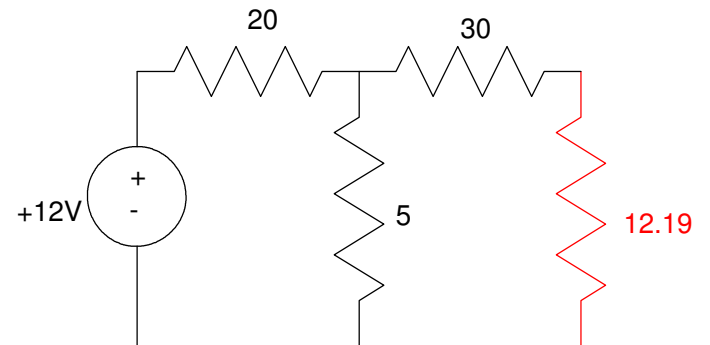
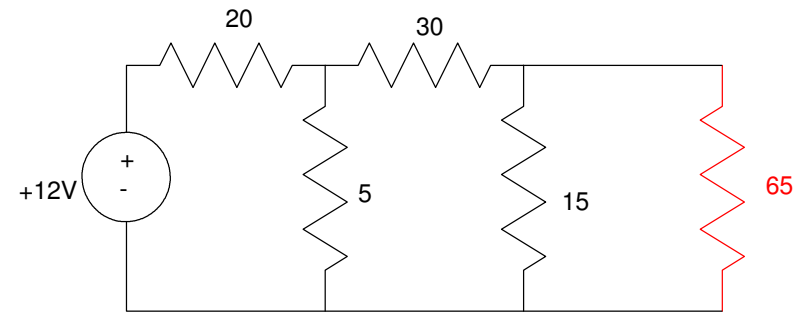
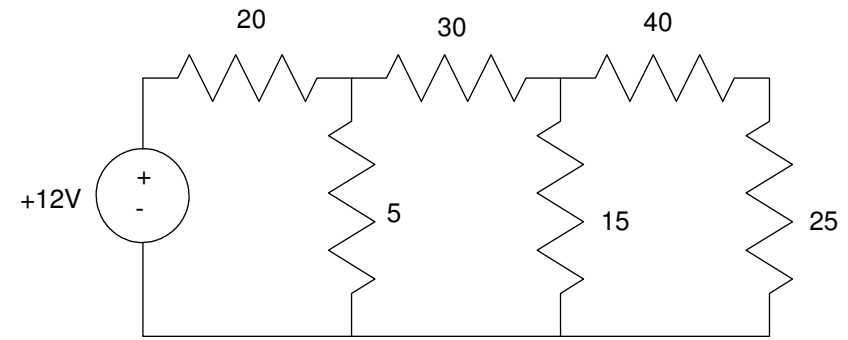
Step 1: Add the 40 Ohm and 25 Ohm resistor in series

$$40\Omega + 25\Omega = 65\Omega$$

Step 2: Combine the 15 Ohm and 65 Ohm in parallel

$$R = 15 \parallel 65$$

$$R = \left(\frac{1}{15} + \frac{1}{65} \right)^{-1} = 12.19\Omega$$



Add 12.19 and 30 ohms in series

$$R = 12.19 + 30 = 42.19$$

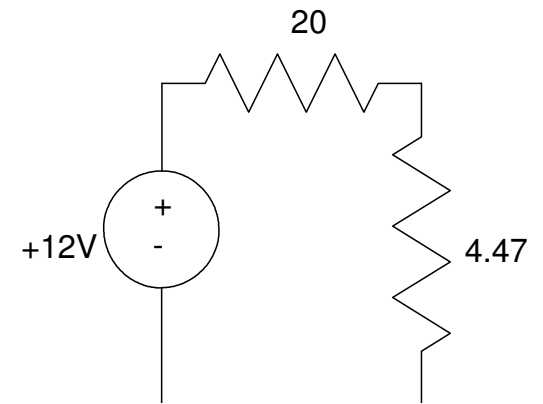
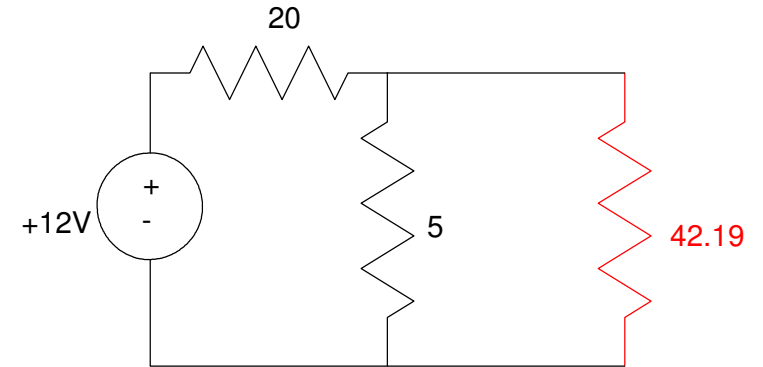
Add 42.19 and 5 in parallel

$$R = 42.19 \parallel 5$$

$$R = \left(\frac{1}{5} + \frac{1}{42.19} \right)^{-1} = 4.47\Omega$$

This is in series with 20 Ohms.

The resistance seen by the 12V source is 24.47 Ohms

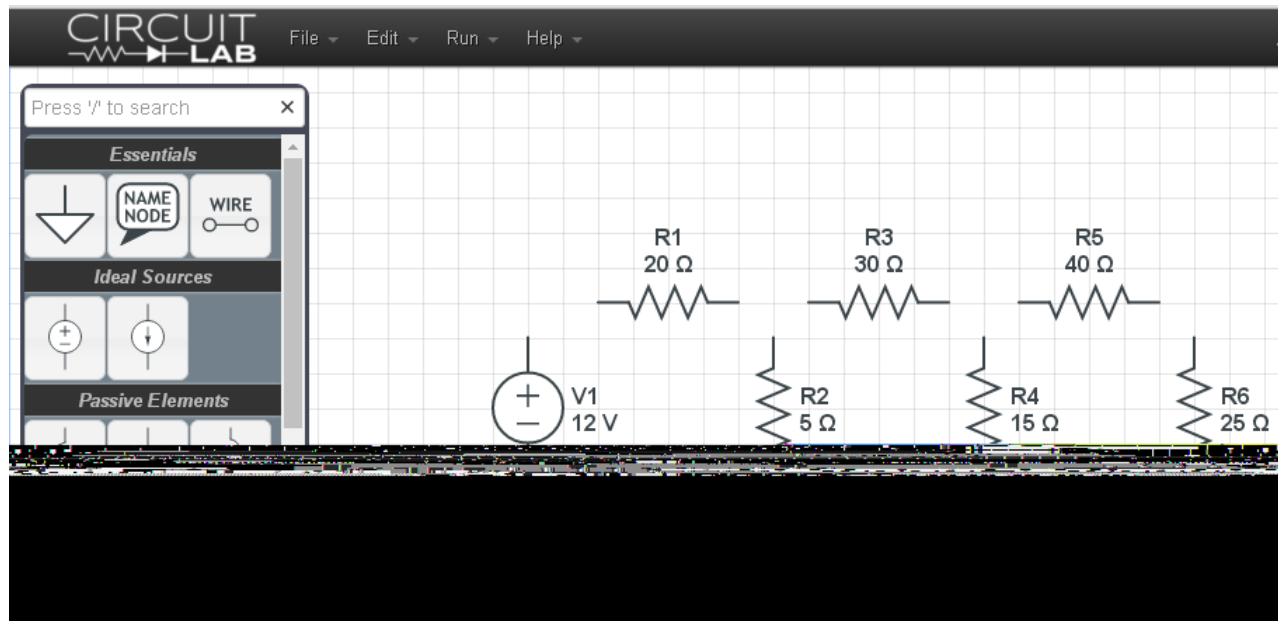


CircuitLab (www.CircuitLab.com)

- Free to use for NDSU students
- Register with your NDSU.edu email address

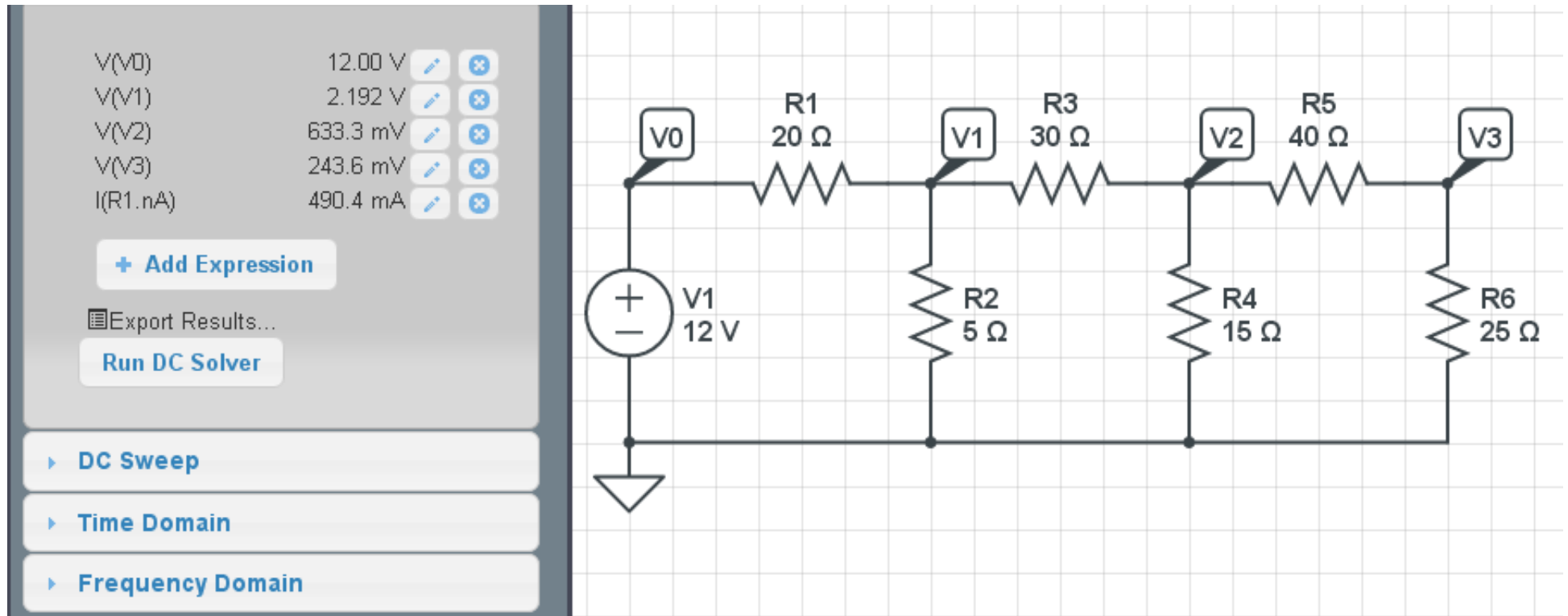
Step 1: Drag and drop the components

- R rotates the component
- Double click to change its value



Step 2: Connect the components using drag and drop. **Note: you should see a dot when wires are connected. No dot means there's no connection.**

Step 3: Click Simulate DC Solver



From $V = IR$, you can compute the resistance seen by the 12V source

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

$$R = \frac{12V}{490.4mA} = 24.469\Omega$$

which matches our computed resistance of 24.47 Ohms.
