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:

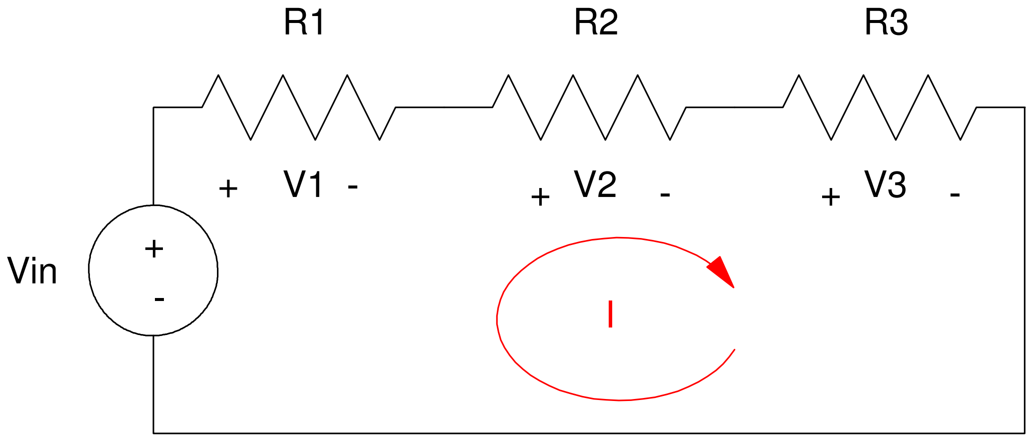
Using Kirchoff's voltage law:

$$Vin = V1 + V2 + V3$$

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

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

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



Resistors in series add

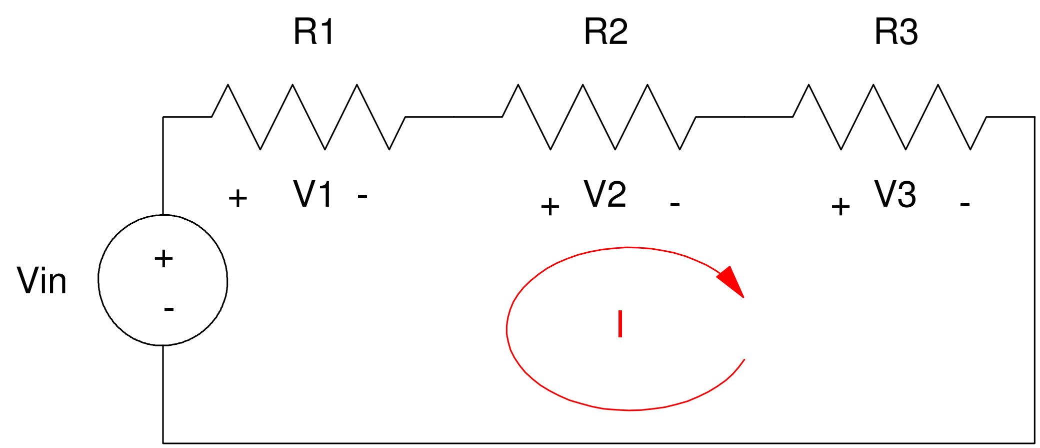
Examples:

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

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

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

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



Let R_1 = 100 Ohms, R_2 = 200 Ohms, R_{net} = 10001000 Ohms. Find R_3.

Answer: Resistors in series add:

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

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

$$\boxed{R_3 = 700\Omega}$$

Resistors in Parallel:

Find the net resistance:

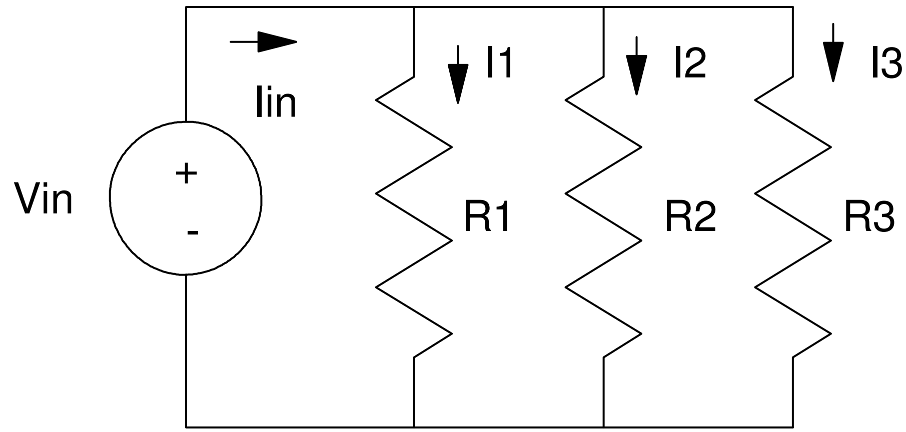
$$I_{in} = I_1 + I_2 + I_3$$

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

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

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

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



In general:

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

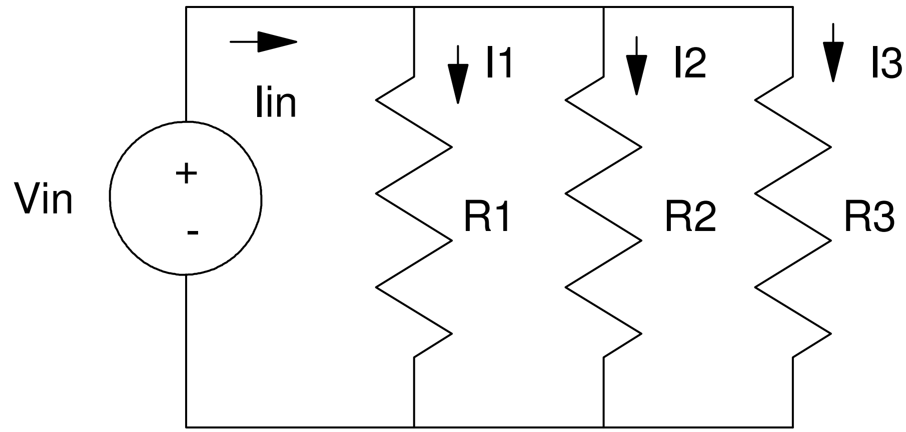
Examples:

Let R1 = 100 Ohms, R2 = 200 Ohms, R3 = 300 Ohms. Find the total resistance.

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

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

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



Let R2 = 200 Ohms, R3 = 300 Ohms,
Rnet = 100 Ohms. Find R1.

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

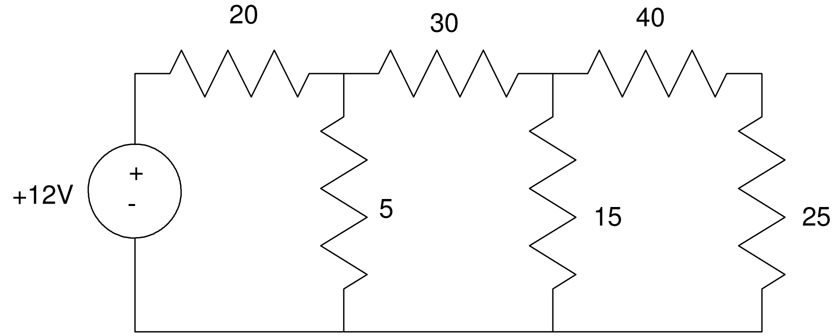
$$100\Omega = \left(\frac{1}{R_1} + \frac{1}{200} + \frac{1}{300}\right)^{-1}$$

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

$$\boxed{R_1 = 600\Omega}$$

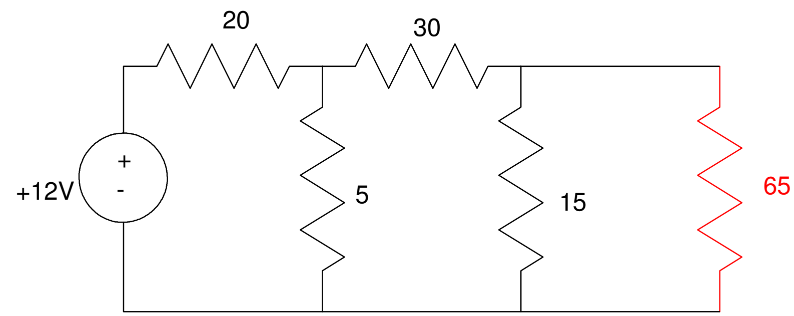
Simplifying Circuits:

- Find the resistance seen by the 12V source



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

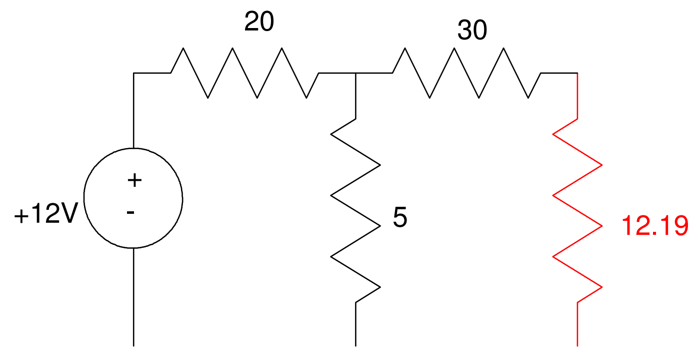
$$40\Omega + 25\Omega = 65\Omega$$



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

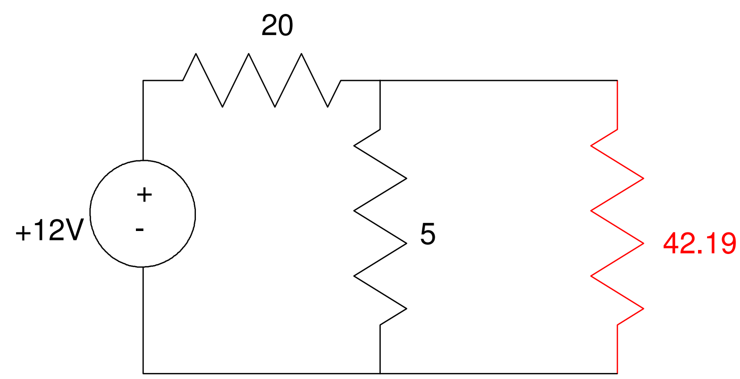
R = 15 || 65

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



Add 12.19 and 30 ohms in series

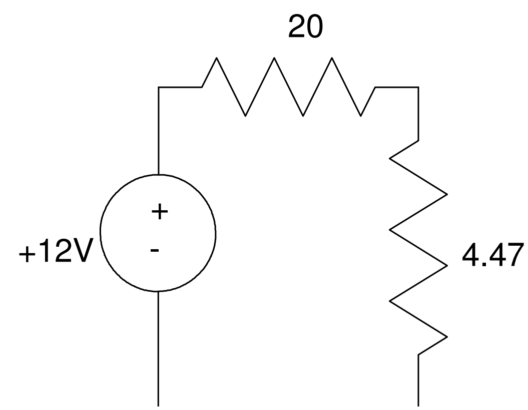
$$R = 12.19 + 30 = 42.19$$



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.

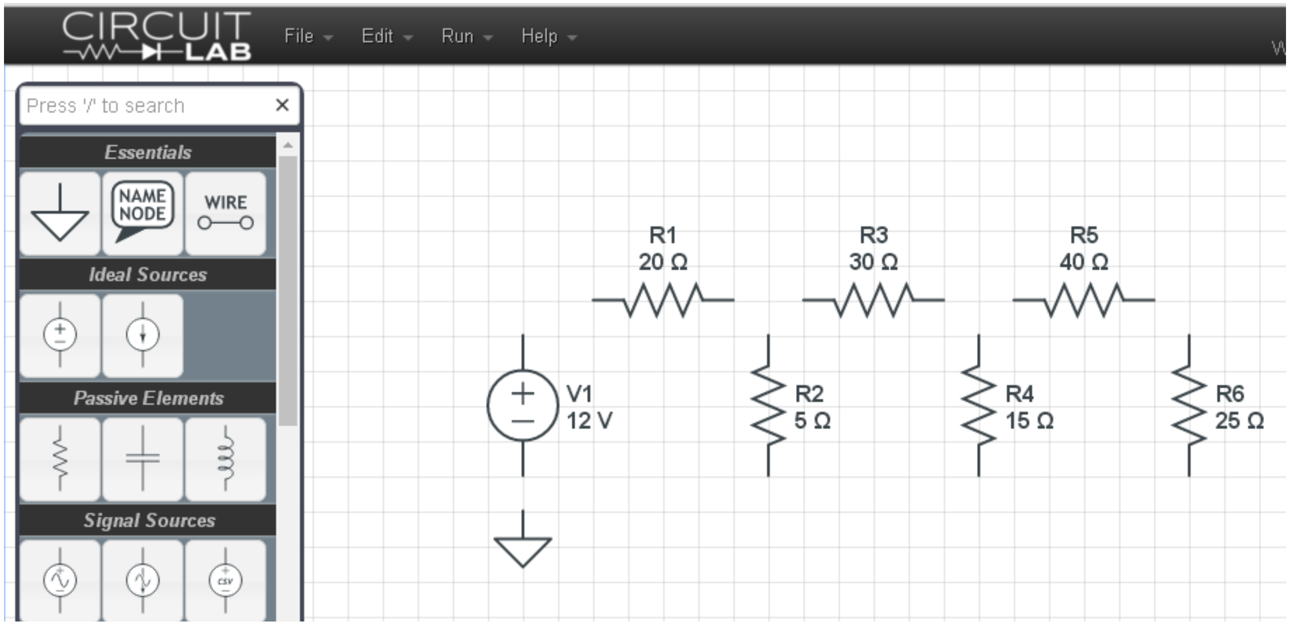
The resistance seen by the 12V source is 24.47 Ohms

CircuitLab (www.CircuitLab.com)

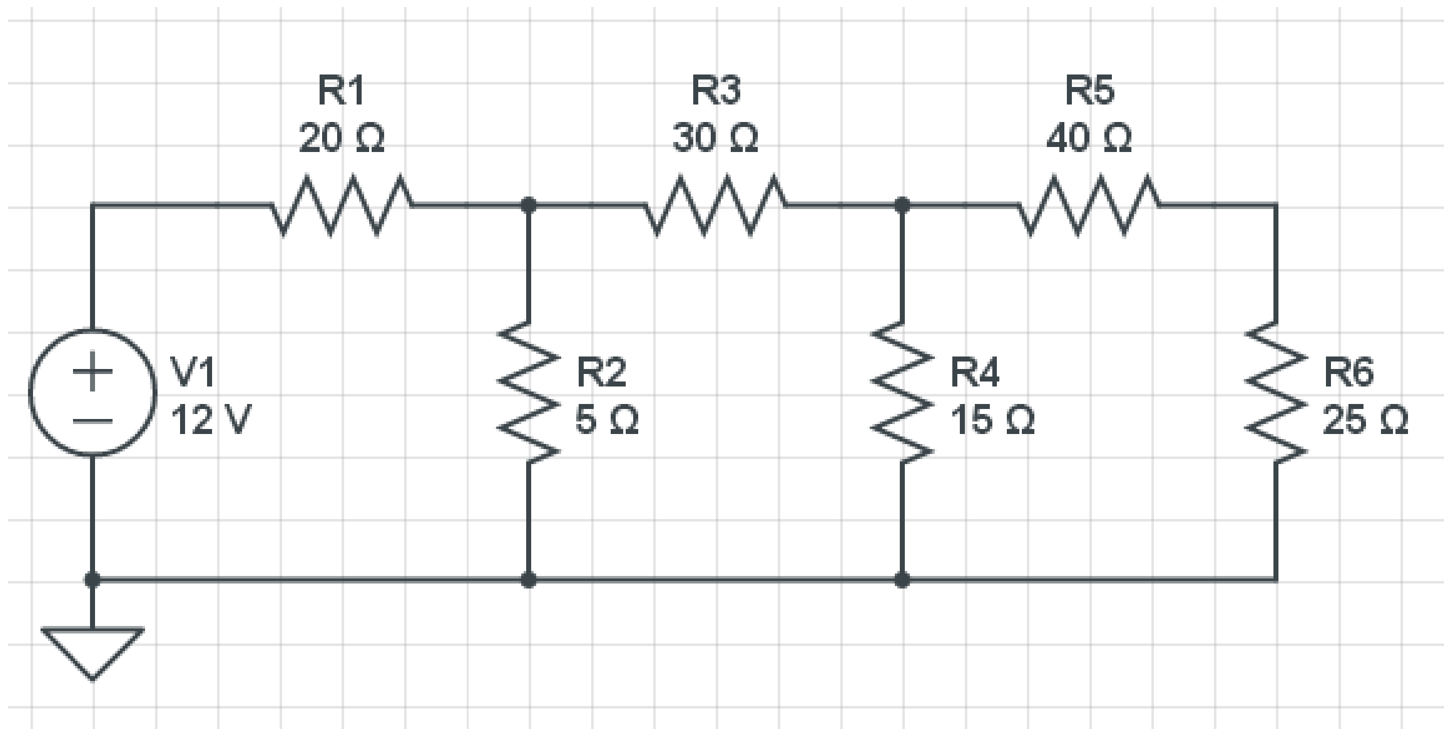
- Free to use for NDSU students
- Register with your NDSU.edu email address

Step 1: Drag and drop the components

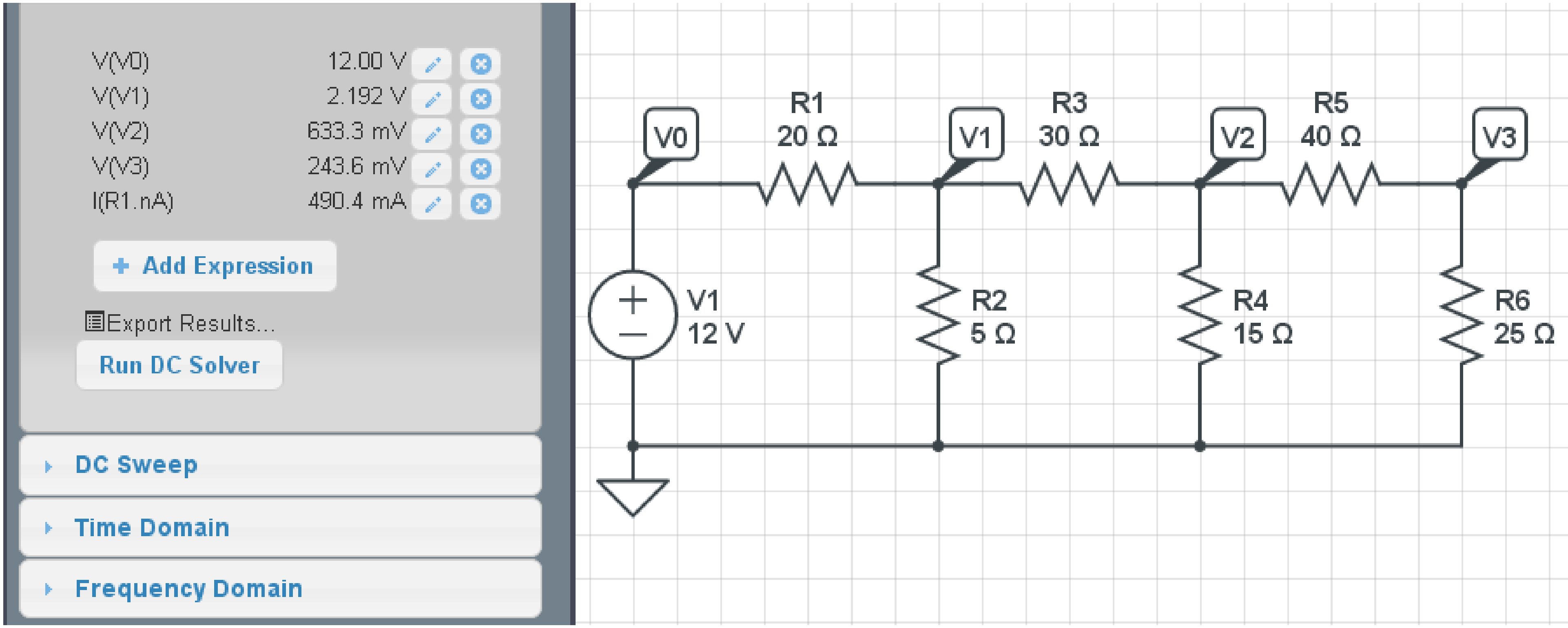
- R rotates the component
- Double click to change its value



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.