Basic Electric Circuits
Series Circuits

ET 150

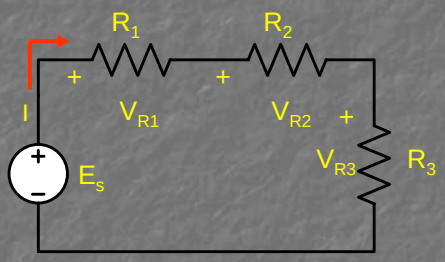
Series Circuit Learning Objectives

- **In this lesson you will:**
- learn the characteristics of a series electric circuit.
- solve a series electric circuit using a voltmeter and Ohm's Law
- see how a series circuit can be used as a voltage divider
- solve example problems
- find the equivalent resistance for a series-connected string of resistors

Series Circuits

Series Circuit Characteristics

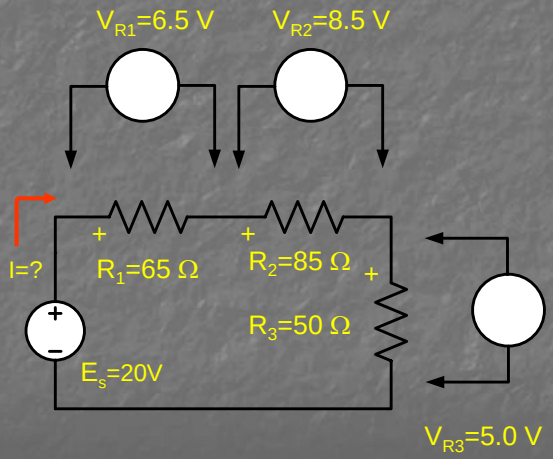
- Components connected end-to-end
- Current only follows one path
- Voltage of source divides between components according to their value
- Sum of component voltage values must equal source value



$E_s = V_{R1}+V_{R2}+V_{R3}$ Kirchhoff's Voltage Law

Series Circuits

Solving series circuits using Ohm's law and a voltmeter



$$I = \frac{V_{R1}}{R_1} = \frac{6.5\,V}{65\,\Omega} = 0.1\,A$$

$$I = \frac{V_{R2}}{R_2} = \frac{8.5\,V}{85\,\Omega} = 0.1\,A$$

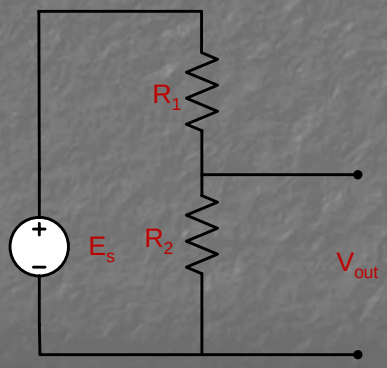
$$I = \frac{V_{R3}}{R_3} = \frac{5.0\,V}{50\,\Omega} = 0.1\,A$$

Current, I same in all resistors

$E_s = V_{R1} + V_{R2} + V_{R3} = 6.5+8.5+5 = 20V$

Series Circuits
The Voltage Divider Circuit

The voltage divider circuit is a series circuit with two resistors



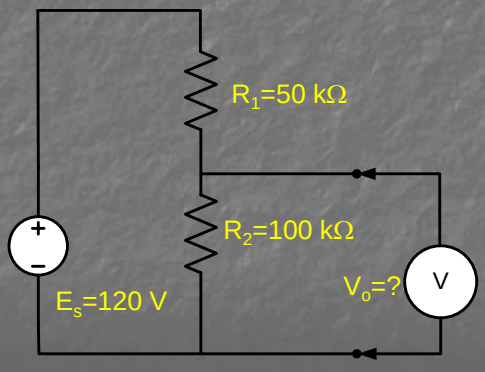
Design Formula

$$V_{out} = \left(\frac{R_2}{R_1 + R_2}\right) E_s$$

Voltage across resistor, R_2, is considered the output of the circuit.

Series Circuits

Example: A 120 V dc source is series connected to a 50 kΩ and a 100 kΩ resistor. (See the figure.) What is the voltage output read by the meter?



$$V_{out} = \left(\frac{R_2}{R_1 + R_2}\right) E_s$$

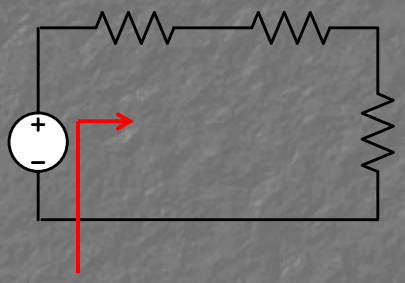
$$V_o = \left(\frac{100\,\text{k}\Omega}{50\,\text{k}\Omega + 100\,\text{k}\Omega}\right) 120\,\text{V}$$

$$V_o = \left(\frac{100\,\text{k}\Omega}{150\,\text{k}\Omega}\right) 120\,\text{V}$$

$$V_o = \left(\frac{2}{3}\right) 120\,\text{V} = 80\,\text{V}$$

Series Resistors

Simplifying series resistors

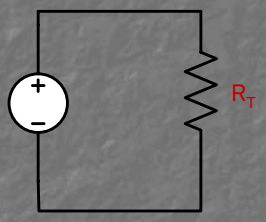


R_T

$R_T = R_1 + R_2 + R_3$

R_T is the equivalent value of the series resistors

Equivalent Circuit



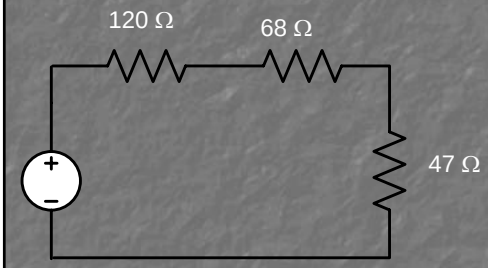
Voltage source will supply the same current, I, to R_T as to $R_1+R_2+R_3$.

This formula works for any number of resistors

R_1 R_2 R_3

Simplifying Series Resistors Example

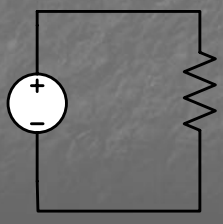
Find the equivalent resistance, R_T, for the circuit below.



$R_T = R_1+R_2+R_3$

$R_T = 120\ \Omega + 68\ \Omega + 47\ \Omega$

$R_T = 235\ \Omega$



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Coming Next: Parallel Electric Circuits

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SERIES CIRCUITS