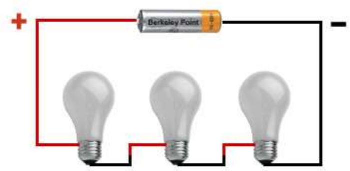
MECH 10
Fundamentals of Electronics

Class 06 – Series Circuits
Ohm's & Watts Law Analysis



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- Lecture Objectives
  - Series circuits
  - Series resistance
  - Kirchoff's Voltage Law
  - Voltage dividers
- Lab
  - Series circuits
  - Voltage dividers
  - Transistors & diodes in series

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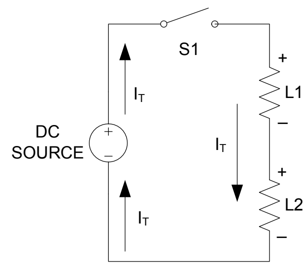
- Series Circuits
  - Any circuit having a single current path
  - Characteristics
    - Single current path
    - Current is equal in all parts of the circuit



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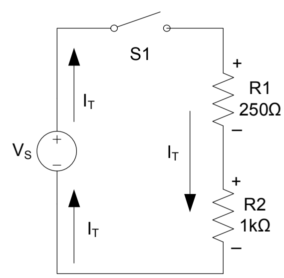
- Series Circuits
  - Series total resistance is equal to the sum of all series connected resistance.

$$R_T = R_1 + R_2 + \ldots R_N$$
$$R_T = 250\Omega + 1k\Omega$$
$$R_T = 1{,}250\Omega$$



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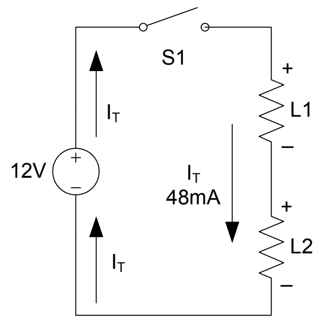
- Series Circuits
  - Series total resistance is directly proportional to total voltage and inversely proportional to total current.

$$R_T = \frac{V_T}{I_T}$$

$$R_T = \frac{12V}{48mA} = 250\Omega$$



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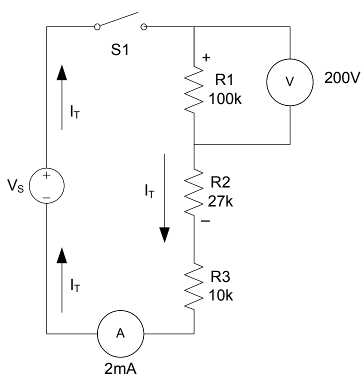
- Series Circuits
  - Component Voltage Drops



$$V_{R1} = I_T \times R_1$$

$$V_{R1} = 2mA \times 100k\Omega$$

$$V_{R1} = 200V$$

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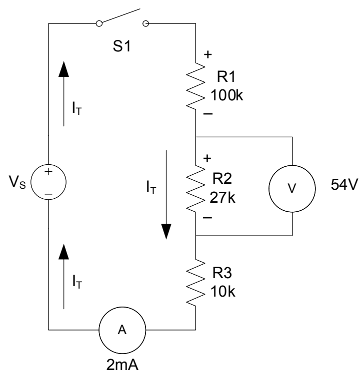
- Series Circuits
  - Component Voltage Drops



$$V_{R2} = I_T \times R_2$$
$$V_{R2} = 2mA \times 27k\Omega$$
$$V_{R2} = 54V$$

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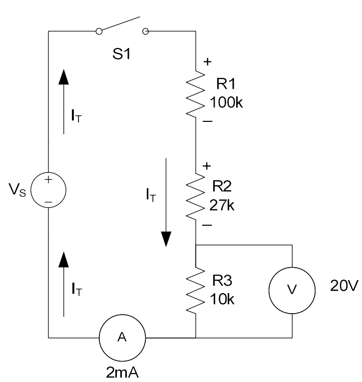
- Series Circuits
  - Component Voltage Drops



$$V_{R3} = I_T \times R_3$$
$$V_{R3} = 2mA \times 10k\Omega$$
$$V_{R3} = 20V$$

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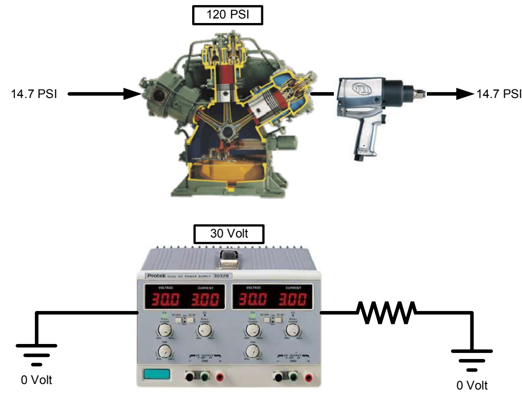
- Series Circuits
  - Kirchhoff's Voltage Law – the sum of circuit voltage drops equals the source voltage.



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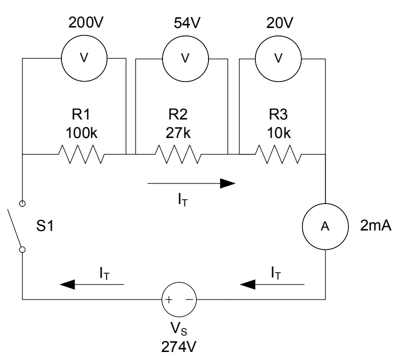
- Series Circuits
  - Kirchhoff's Voltage Law – the sum of circuit voltage drops equals the source voltage.



$$V_S = V_{R1} + V_{R2} + V_{R3}$$
$$V_S = 200V + 54V + 20V$$
$$V_S = 274V$$

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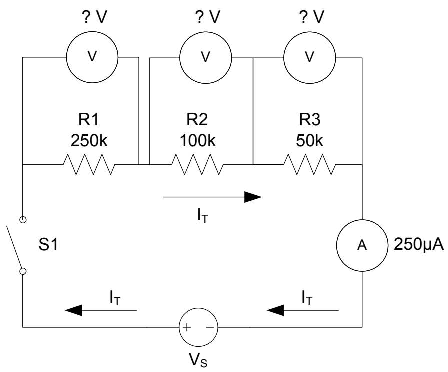
- Series Circuits
  - KVL – example

$$V_{R1} = I_T \times R_{R1}$$
$$V_{R2} = I_T \times R_{R2}$$
$$V_{R3} = I_T \times R_{R3}$$



$$V_{R1} = 250\mu A \times 250k\Omega = 62.5$$
$$V_{R2} = 250\mu A \times 100k\Omega = 25V$$
$$V_{R3} = 250\mu A \times 50k\Omega = 12.5V$$
$$V_T = V_{R1} + V_{R2} + V_{R3} = 100V$$

$$V_T = I_T \times R_T$$
$$V_T = 250\mu A \times 400k\Omega = 100V$$

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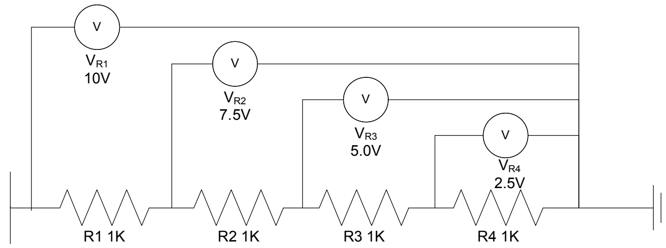
- Series Circuits
  - KVL – voltage divider
    - (+) Easily split voltages for component level needs
    - (-) Backbone circuit losses are large

$$V_{R1} = I_T \times R_T = 2.5mA \times 4k\Omega = 10V$$
$$V_{R2} = I_T \times (R_2 + R_3 + R_4) = 2.5mA \times 3k = 7.5V$$
$$V_{R3} = I_T \times (R_3 + R_4) = 2.5mA \times 2k = 5.0V$$
$$V_{R4} = I_T \times R_4 = 2.5mA \times 1k = 2.5V$$



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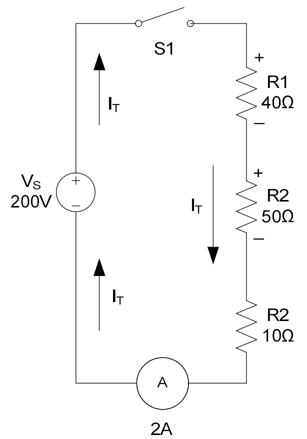
- Power in Series Circuits
  - Component Power

$$P_{R1} = {I_T}^2 \times R_{R1}$$
$$P_{R2} = {I_T}^2 \times R_{R2}$$
$$P_{R3} = {I_T}^2 \times R_{R3}$$



$$P_{R1} = {I_T}^2 \times R_{R1} = (2A)^2 \times 40\Omega = 160W$$

$$P_{R2} = {I_T}^2 \times R_{R2} = (2A)^2 \times 50\Omega = 200W$$

$$P_{R3} = {I_T}^2 \times R_{R3} = (2A)^2 \times 10\Omega = 40W$$

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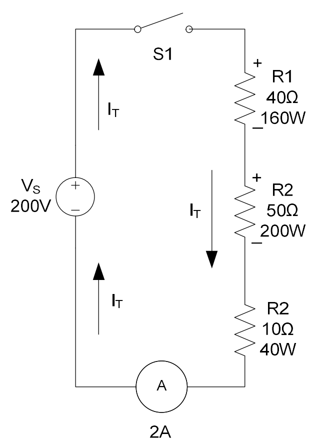
- Power in Series Circuits
  - Net Power

$$P_T = P_{R1} + P_{R2} + P_{R3}$$
$$P_T = V_T \times I_T$$
$$P_T = I_T^2 \times R_T$$
$$P_T = \frac{V_T^2}{R_T}$$



$$P_T = P_{R1} + P_{R2} + P_{R3}$$
$$P_T = 160W + 200W + 40W$$

$$P_T = V_T \times I_T$$
$$P_T = 200V \times 2A$$

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Lab 06 – Series Circuits

Learning Objectives

- Build series circuits as per a schematic diagram
- Measure electrical values using a digital voltmeter
- Use Ohm's Law to validate field measurements
- Use a data table and schematic diagrams to capture field measurements

		Points Possible
Documentation	Quality of documentation (neatness, clarity, spelling, grammar), Expected and measured values recorded on schematic diagram	10
Circuit 1	Expected and measured resistance values recorded in data table with percent error	5
	Expected and measured total resistance and circuit current recorded in data table with percent error	5
	Expected and measured resistor voltage drops recorded in table with percent error	5
Circuit 2	Expected and measured total resistance and circuit current recorded in data table with percent error	5
	Expected and measured resistor voltage drops recorded in table with percent error	5
Circuit 3	Min / max voltage levels recorded	5
Circuit 4	Expected and measured total resistance and circuit current recorded in data table with percent error	5
	Expected and measured resistor voltage drops recorded in table with percent error	5
Circuit 5	V_S, V_{LED}, V_{R1}, V_{CE} recorded. Total voltage drop calculated and compared with V_S using the % Error formula	5
Conclusions	Qestions answered completely & accurately	10
	Total	65