

Voltage Divider

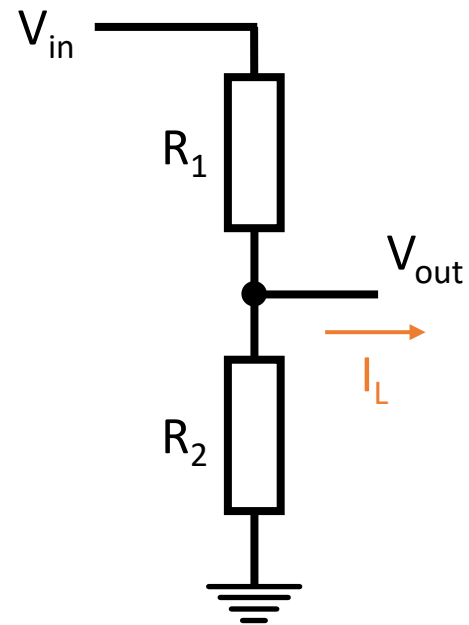
Applied Mechatronics

First Grade Level

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Voltage Divider (1)

- Mode of Operation
 - Reduce voltage with the aid of resistors
 - Two resistors in series
 - Two modes
 - Unloaded voltage divider
 - No current load on V_{out}
 - Loaded voltage divider
 - With current load on V_{out}



Voltage Divider (2)

- Unloaded voltage divider

- Given values

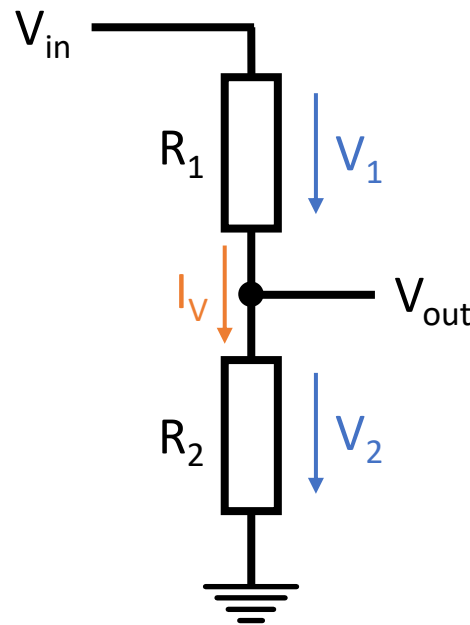
- R_1, R_2, V_{in}

- Required values

- V_{out}, I_V, P_{tot}

- Relations

- $R_{tot} = R_1 + R_2$
 - $V_{in} = V_1 + V_2$
 - $V_{out} = V_2$
 - $I_V = \frac{V_{in}}{R_{tot}} = \frac{V_1}{R_1} = \frac{V_2}{R_2}$
 - $P_{tot} = V_{in} \cdot I_V$



V_{in} : Input Voltage

V_{out} : Output Voltage

I_V : Vertical Current

R_{tot} : Total Resistance

P_{tot} : Total Power =
Power Loss

Voltage Divider (3)

- Unloaded voltage divider

- Derivation

- $\frac{V_{in}}{R_{tot}} = \frac{V_2}{R_2}$

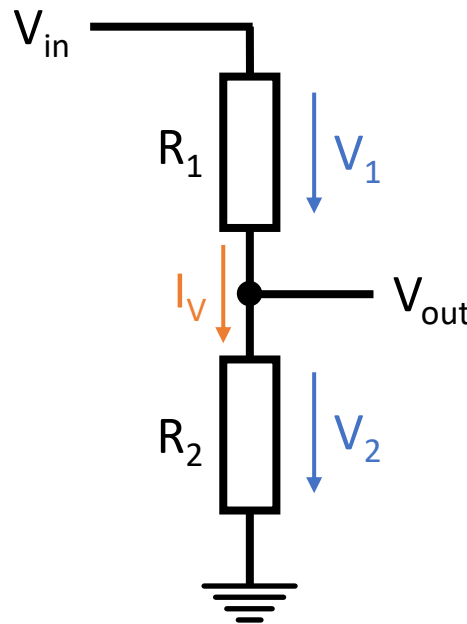
- $V_2 = \frac{R_2}{R_{tot}} \cdot V_{in}$

- Formulas

- $V_{out} = \frac{R_2}{R_1 + R_2} \cdot V_{in}$

- $I_V = \frac{V_{out}}{R_2}$

- $P_{tot} = \frac{V_{out}}{R_2} \cdot V_{in}$



$$I_V = \frac{V_{in}}{R_{tot}}$$
$$I_V = \frac{V_2}{R_2}$$

Voltage Divider (4)

- Unloaded voltage divider

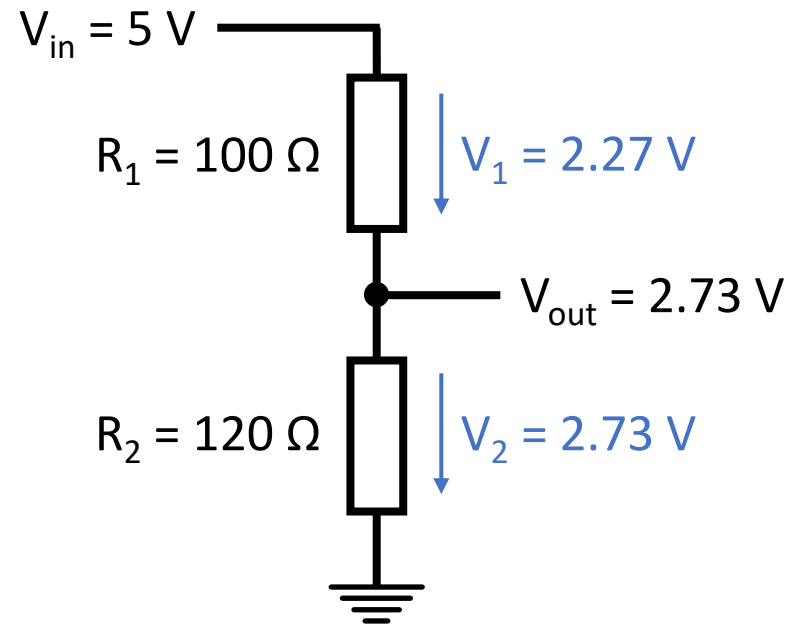
- Example

- Given values

- $V_{in} = 5\text{ V}$
 - $R_1 = 100\ \Omega$
 - $R_2 = 120\ \Omega$

- Calculation

- $$V_{out} = \frac{R_2}{R_1 + R_2} \cdot V_{in}$$
$$= \frac{120\ \Omega}{100\ \Omega + 120\ \Omega} \cdot 5\text{ V}$$
$$= 2.73\text{ V}$$



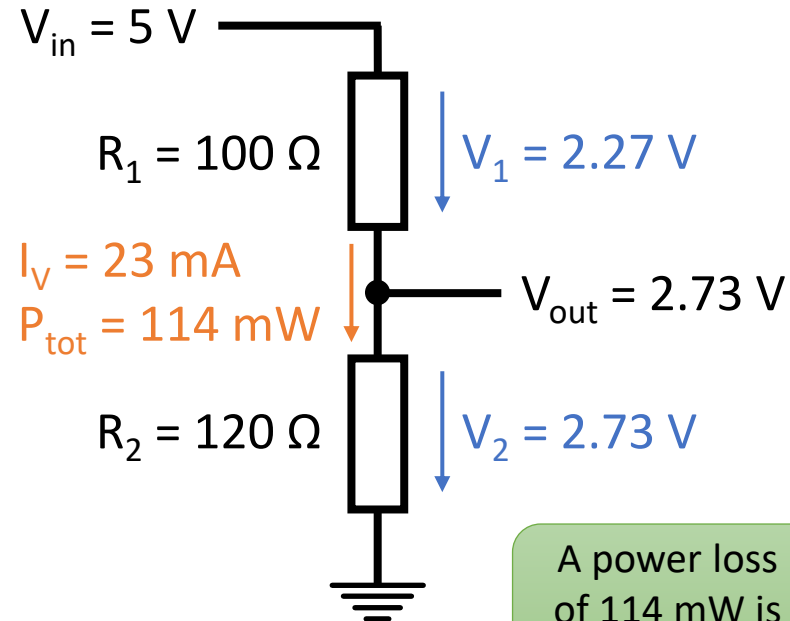
Voltage Divider (5)

- Unloaded voltage divider

- Calculation

- $I_V = \frac{V_{out}}{R_2}$
 $= \frac{2.73 V}{120 \Omega}$
 $= 23 mA$

- $P_{tot} = \frac{V_{out}}{R_2} \cdot V_{in}$
 $= \frac{2.73 V}{120 \Omega} \cdot 5 V$
 $= 114 mW$



A power loss of 114 mW is relatively high.

Voltage Divider (6)

- Voltage Divider with Amplifier
 - Loaded voltage divider are difficult to handle
 - Current load may be unknown
 - Current load may vary
 - An amplifier can eliminate the load

