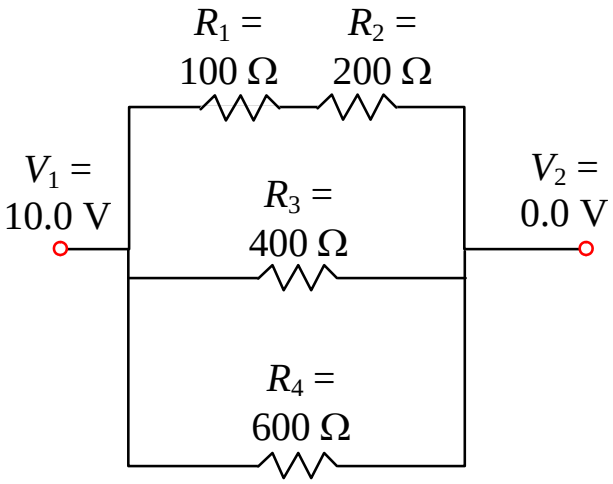
Today, we will:

- Do some example problems – basic electronics and dimensional analysis
- Review the pdf module: **Errors and Calibration** and do some example problems
- Review the pdf module: **Basic Statistics** and do some example problems

Example: Basic electronics

Given: The circuit shown.



To do:

(*a*) Calculate the equivalent resistance of this circuit.

(*b*) Calculate the total current through this circuit.

(*c*) Calculate the power used by this circuit.

Solution:

Example: Basic electronics

Given: A bunch of 10 kΩ resistors is available in the lab. We have need for a resistance of 22 kΩ for a circuit we are building on a breadboard.

To do: Figure out how to create the required resistance from the available resistors.

Solution:

Example: Basic electronics

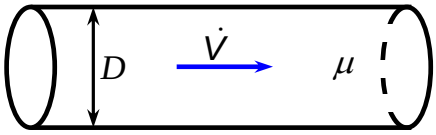
Given: A voltage signal has a DC offset. We want to remove the DC offset so that the frequency content of the AC (fluctuating) component can be analyzed.

To do: Figure out how to remove the DC offset with a *single* electronic component (i.e., one resistor *only*, or one capacitor *only*, or one inductor *only*, etc.).

Solution:

Example: Dimensional analysis – pipe flow

Given: Consider fully developed laminar flow through a very long round tube. Volume flow rate $\dot{V}$ is a function of the tube's inner diameter D, fluid viscosity μ, and axial pressure gradient dP/dx.



Pressure gradient = dP/dx

To do: If D is doubled, holding μ and dP/dx fixed, by what factor does $\dot{V}$ change?

Solution: Use dimensional analysis to generate a nondimensional functional relationship.

Step 1:

Step 2:

Step 3:

Step 4:

Step 5:

Step 6:

Answer: If D is doubled, holding μ and dP/dx fixed, $\dot{V}$ goes up by a factor of ____.

Example: Errors and calibration

Given:

- The actual (true) voltage is 4.6020 V.
- 256 voltage readings are taken, and the average voltage reading is 4.6015 V.

To do: **(*a*)** Calculate the systematic (bias) error and the mean bias error for this set of measurements. **(*b*)** Calculate the random (precision) error of a reading that is 4.6010 V.

Solution:

(*a*)

(*b*)

Example: Errors and calibration

Given:

- The actual (true) temperature is 22.100°C.
- Six thermometer readings are taken: 22.15, 22.22, 22.09, 22.21, 22.18, and 22.24°C.

To do: Calculate the mean, systematic error, and mean bias error for this set of data, and calculate the accuracy error (inaccuracy) and the precision error for each measurement.

T_i (°C)	Inaccuracy = $T_i - T_{true}$ (°C)	Precision error = $T_i - \overline{T}$ (°C)
22.15		
22.22		
22.09		
22.21		
22.18		
22.24		

Solution:

[See also Excel spreadsheet on the website for this same problem]