Design Challenge 2: SensorCraft

1 Goal

The goal of this design challenge is to experiment with voltage, current, resistors, and circuits. You will work in teams to accomplish amazing feats of sensor measurement talent. To do this, you will build voltage divider circuits and use each sensor to measure some external event.

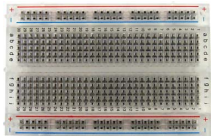
2 Materials:

Apparently, you need a lot of stuff to run a sensor lab:

2.1 Materials for Each Team:


Battery pack

AA batteries (x2)


Breadboard


Resistors


Multimeter


Flash Light

2.2 Basic Sensors for Each Team:


Light Sensor


Push-Button switch

2.3 Advanced Sensors for Each Team:


Potentiometer


Temperature Sensor

2.4 Bonus Sensors (to share as a class)


Big bend sensor (x3)


Little bend sensor (x5)

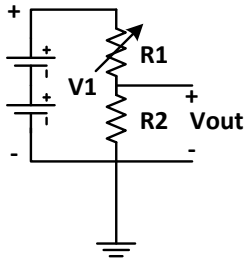
3 Phases:

This design challenge is broken up into two phases.

Phase I: In this phase, each team will complete sensing with the four basic sensors. This phase will not end until all teams have completed sensing with the basic sensors. *Each team member must physically handle the breadboard and resistors to complete at lease one of these sensors*. Other team members can help, but every member must spend time building and creating. The teaching assistants will help any team that is stuck.

Phase II: This phase will be a frantic competition to earn the most points and win the challenge. Teams will attempt to gain as many points as possible from the scoring table below within the time limit (until the end of class). You will be on your own during this phase, so if you are stuck on a challenge or problem, move on to the next!

4 The Rules:



1. You must use the basic schematic above for this challenge. You can replace either resistor $R1$ or resistor $R2$ with your sensor. You must use at least one resistor and one sensor, but can use more resistors if you need to.

2. You can only use the resistors in your kit: 1k, 4.7k, 6.8k, 10k, and 22k. You may not trade or borrow resistors from other teams.

3. You can (and will need to) use other materials for these achievements: cardboard, tape, paper, scissors – anything in the official ENGI 128 Arts & Crafts Bin. However, you may not be wasteful (up to the discretion of the TAs) You can also use anything you brought with you. (In case you brought your own cardboard, tape, paper, or scissors.) You may *not* use items from the classroom, including tables and chairs.

4. For most of the achievements, your circuit must have a output voltage, v_{out}, of $2.5v - 3.5v$ when the sensor is activated, and v_{out} of $0v - 2.49v$ when the sensor is not activated.

5 Scoring:

You score points by completing specific feats of sensor measurement strength. Each of these achievements is worth a different number of points. You can only get each achievement once. *It is not possible to finish this entire list*, don't try to do so. Read through it to find fun/easy achievements to work on.

Basic Advancedness (1pt): Successfully test one of the advanced sensors in your kit.
Flexibility (1pt): Successfully test either of the bend sensors.
Total Domination (2pts): Successfully test all 6 sensors.
Early Bird (1pt): Be the first to successfully test any non-basic sensor. There are four total achievements for this, each worth 1pt. Each team can only win one early bird achievement.
Earlyish Bird (1pt): Be the second to successfully test any non-basic sensor. There are four total achievements for this, each worth 1pt. Each team can only win one earlyish bird achievement.
Need Moar Resistance! (1pt): Complete any of the challenges using a circuit with more than one resistor in it.
Turn on the Lights (4pts): Get the highest light sensor voltage output. Your circuit must produce a *swing* of $> 0.5v$. The swing is the difference in v_{out} between when the sensor is lit, and when it is dark.
Night Vision (4pts): Get the most sensitivity from the light sensor. We will measure this by the distance your circuit can detect the flashlight. For this challenge, we will accept any change (from light) in v_{out} when measured on the 20v DC scale.
Angry Bird (5pts): Get any circuit to produce a voltage ($v_{out} = 2.5v - 3.5v$) by throwing an Angry Bird plush toy at it. You must be at least 2 meters from your sensor when you throw. We only have a few Angry Birds, so you have to share your bird with anyone else trying to win this achievement.
Long Distance (5pts): Successfully test any sensor from the longest distance *without* throwing an object at it. You must stay in the classroom.
Thermonuclear (3pts): Get the highest voltage output from the temperature sensor. The circuit must produce higher voltages for higher temperatures. Your circuit must produce a *swing* of $> 0.5v$ from room temperture to your cold source.
Sub-Zero (3pts): Get the lowest voltage output from the temperature sensor. The circuit must produce *higher voltages* for *higher temperatures*. Your circuit must produce a *swing* of $> 0.5v$ from room temperature to your hot source.

6 Hints:

Stuck? Keep in mind that for all of these sensors, the basic schematic from above is the same, and only the sensor and resistors change. Remember, your teammates are your friends: A few minutes of brainstorming can save 30 minutes of individual work. Don't be afraid to test your sensors and see what happens. We're pretty sure you can't break anything, and have plenty of spare parts if you do. Get started testing quickly!

SensorCraft Scoresheet

Basic Advancedness (1pt): Successfully test one of the advanced sensors in your kit.
Accomplished: _____

Flexibility (1pt): Successfully test either of the bend sensors. Accomplished: _____

Total Domination (2pts): Successfully test all 6 sensors. Accomplished: _____

Early Bird (1pt): Be the first to successfully test any non-basic sensor. There are four total achievements for this, each worth 1pt. Each team can only win one early bird achievement.
Accomplished: _____ Sensor: _____

Earlyish Bird (1pt): Be the second to successfully test any non-basic sensor. There are four total achievements for this, each worth 1pt. Each team can only win one earlyish achievement.
Accomplished: _____ Sensor: _____

Need Moar Resistance! (1pt): Complete any of the below challenges using a circuit with more than one resistor in it.
Accomplished: _____ Challenge: _____

Turn on the Lights (4pts): Get the highest light sensor voltage output for a bright light. Your circuit must produce a *swing* of $0.5v$. The swing is the difference v_{out} between when the sensor is lit, and when it is dark.
Accomplished: _____ Voltage: _____

Night Vision (4pts): Get the most sensitivity from the light sensor. We will measure this with distance: by moving a standard lab flashlight further from your sensor while looking for any change in the voltmeter output when measured on the $20V$ DC scale.
Accomplished: _____ Distance: _____

Angry Bird (5pts): Get any sensor to trigger ($v_{out} = 2.5v - 3.5v$) by throwing an Angry Bird plush toy at it. You must be at least 2 meters from your sensor when you throw.
Accomplished: _____ Distance: _____

Long Distance (5pts): Activate any sensor from the longest distance *without* throwing an object.
Accomplished: _____ Distance: _____

Thermonuclear (3pts): Get the highest voltage from the temperature sensor. The circuit must produce higher voltages for higher temperatures. Your circuit must produce a swing of $> 0.5v$ from room temperature to your hot source.
Accomplished: _____ Voltage: _____

Sub-Zero (3pts): Get the lowest voltage output from the temperature sensor. The circuit must also produce higher voltages for higher temperatures. Your circuit must produce a swing of $> 0.5v$ from room temperture to your cold source.
Accomplished: _____ Voltage: _____