Calibration of Conductivity Sensors

ME 121
Calibration

- Associate sensor output with salt concentration
- Relate sensor output and salt concentration using an equation (linear regression)
- The goal is to be able to compute the salt concentration based on sensor output
The Basic Idea

- Adding salt to the water will increase the availability of Cl\textsuperscript{-} ions at the anode.
- More ions at the anode will increase the rate at which chemical reactions can occur.
- The “electrical resistance” of the salt water will decrease as more salt is added to the water.
- The analog voltage on the + side of the 10kΩ resistor will increase as more salt is added.
- Correlating this voltage with the salt concentration will allow us to “calibrate” the conductivity sensor.
# The Circuit and Sketch

```cpp
int salinity_power_pin = 4;  // Digital I/O pin, Global variable

void setup()
{
    Serial.begin (9600);
    pinMode (salinity_power_pin, OUTPUT);
}

void loop()
{
    int salinity_input_pin = 2;  // Analog input pin
    int salinity;

    salinity = sensor_reading( salinity_power_pin, salinity_input_pin );
    Serial.println (salinity);
}

// ----------------------------------
int sensor_reading( int power_pin, int input_pin ) {

    int reading;

    digitalWrite (power_pin, HIGH );  // Turn on the sensor
    delay(100);  // Wait to settle
    reading = analogRead (input_pin );  // Read voltage
    digitalWrite (power_pin, LOW );  // Turn off the sensor
    return reading;
}
```

![Circuit diagram](diagram.png)
Salt Concentrations

- Each group of students should put about 1.5 inches of water in four bottles
- The four bottles should contain . . .
  - DI water
  - 0.05% weight NaCl
  - 0.10% weight NaCl
  - 0.15% weight NaCl
- Please take ONLY the amount that you will need to use TODAY
- Be sure to label your water bottles
- Swish a small amount of DI water around in your bottle to wash out impurities before filling with calibration water
Capture data during calibration

- Copy and paste to Excel

Click the Autoscroll button to temporarily suspend updates to the screen. This is helpful when manually copying data to another application.
Calibration steps in the lab

1. Configure your flow loop as required for homework
2. Implement the conductivity sensor circuit on your breadboard
3. Flush tank with DI water.
   a. Pour enough DI water into your fishtank to fill the flow loop
   b. Turn on the pump to run the flow loop for about a minute to “wash out” the impurities.
   c. Turn the three-way valve toward the drain to flush the system
   d. Repeat to completely clean the system
4. Fill the system with DI water
5. Collect calibration data
   a. Wait for the system to come into equilibrium
   b. Copy a large amount (50 to 100) of readings from the Serial Monitor to a text file or Excel
   c. Save the file with a name that allows you to identify it later
6. Fill the system with 0.05 wt% salt water. Flush once, and refill with 0.05 wt% salt water
7. Repeat steps 5a through 5c
8. Repeat steps 5 through 7 for 0.10 wt% salt water and 0.15 wt% salt water
Analysis of calibration data

1. Use MATLAB to create a histogram of your data
2. Compute the mean, standard deviation and median of the data
3. Record the data in the following table

<table>
<thead>
<tr>
<th>Wt% NaCl</th>
<th>n</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.15</td>
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</tr>
</tbody>
</table>
Fit Output of Sensor to Salt Concentration

1. Use the mean data for each concentration and plot it in MATLAB.
2. Add a curve fit.