Importance of Calibration

Besides compromising performance, component life, and sometimes even safety, improperly-calibrated tools result in work that is not only less than optimal but can be dangerous! Engineering and medical technicians' work is only as good as the tools and instruments they use. If the instruments are worn and out of calibration, then the work they do with them is substandard. Prevention is the key way to extend accuracy. In the case of electronics even digital tools are made of physical materials that exist in the real world of heat, humidity, and electricity. Even with instrumentation that is just sitting on the shelf, it will change with time, so checking is necessary even with little to no use. As such, even the best of tools can go off-spec over time, which is why regular calibration tests are a necessity.

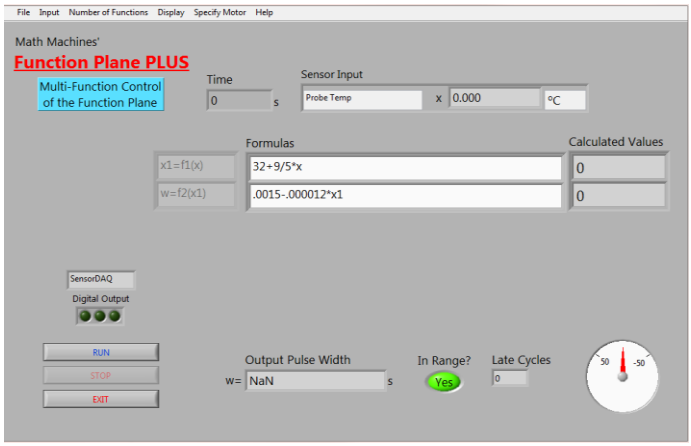
Heart Monitor

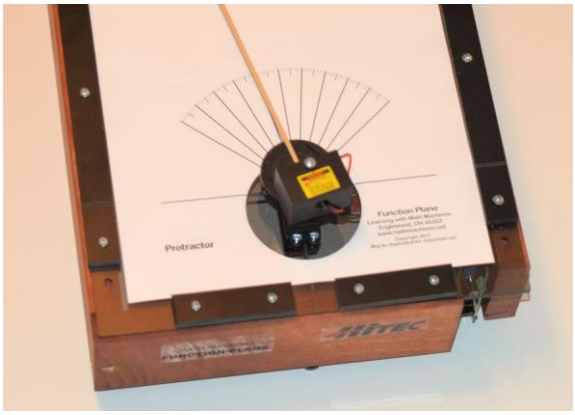
Task: In this activity you will be given several situations that will require you to create a gauge for the output of a function.

Additional Materials: temperature probe, blank paper protractor template, -50°-50° transparency overlay, ice water.

Math Machines Program:
Function Plane Plus

Activity Files: Gauge00x





Initial Setup

Plug Temperature Probe into channel 1 of the SensorDAQ. Run the FunPlanePlus program and answer yes in the "Analog Probe in Ch.1" window. Load Activity File Gauge001.

Place the blank paper protractor on your function plane and the -50°-50° transparency overtop of it. For any degree value 'x1', the function in the bottom formula window will calculate a value for 'w' that will move the servo to the correct position on the -50°-50° scale. Test this by putting in various values for 'x1' in the top formula window and selecting the [RUN] button. The servo should move the laser to the correct position on the scale.

Part 1, Changing to Fahrenheit

1. The SensorDAQ monitors the temperature probe and stores value it receives to the variable x in °C. Determine the function 'f1(x)' to convert the temperature probe's readings 'x' to degrees Fahrenheit, 'x1'.

   x1 = _____

2. What measurements did you have to make to determine your 'x1' function? How was this function created? (Show your work)

3. Is your function a linear function? If so, explain what the slope and intercept values represent.

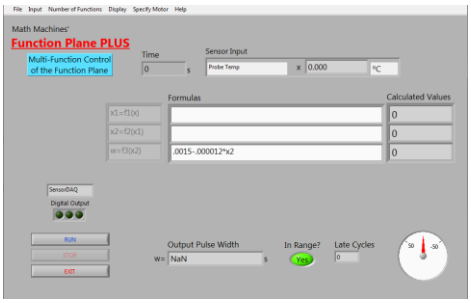
Test your function for various temperatures. Try it for room temperature & the ice water. After you have the probe ice water you can warm it up quickly by holding it tightly in your hand.

4. For this particular gauge, what would you give as the domain and range for your function based on the gauge? Is this practical for the temperatures of ice water to room temperature?

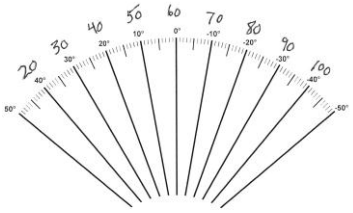
Part 2, A Better Scale

You may have found that the protractor on the Function Plane is inadequate for some temperatures. Continue this activity to recalibrate your protractor to make it work for a broader range of temperatures.

Load Activity File, Gauge002.



In this part of the activity you will convert the Fahrenheit temperature to a different position on the template so that any temperature readings from 20 to 100 can be displayed. Notice that there are three formula windows in Gauge002. Place the function you used to convert °C to Fahrenheit in the top window.



5. Broaden the range of your 'x1' function by first labeling the protractor grid on your function plane with 20 to 100 degrees instead of 40 to -40 degrees. Determine the function 'x2' to convert the Fahrenheit temperature 'x1' to the correct angle position on your new gauge. Write both functions below.

   x1 = _____

   x2 = _____

6. What measurements did you have to make to determine your 'x2' function? How was this function created?

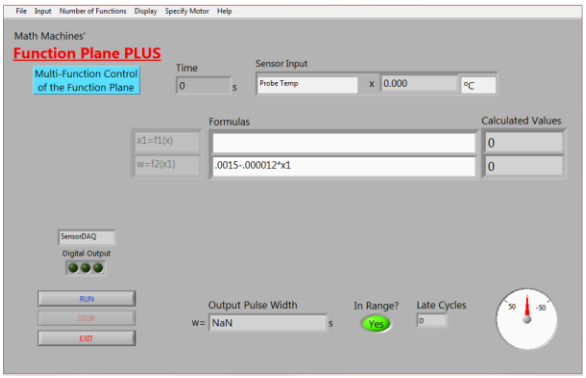
7. Is 'x2' a linear function? If so, explain what the slope represents.

8. Test your system and report on how it is working. Does the reading output on your gauge match the reading of the probe for cold and warm temperatures?

Part 3, A More Efficient Calculation

Make your program more efficient by creating just 1 function to accomplish the same task.

Load Activity File Gauge003.



9. Determine one function to convert the temperature probe's readings 'x' (in degrees Celsius) to degrees Fahrenheit, 'x1', on your 20 to 100 degree temperature scale.

   x1 = _____

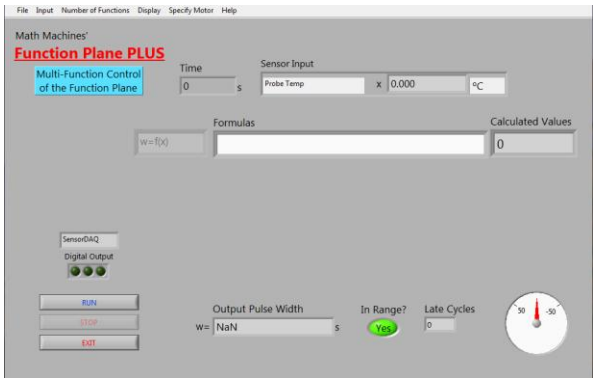
10. What measurements did you have to make to determine your 'x1' function? How was this function created?

11. What is the advantage in reducing the number of calculations the computer has to make?

Challenge:

In light of your answer to question 12, can you make just one function that does it all! The function takes the input from the probe and converts it to a signal that positions the servo to the correct number of degrees set by your scale.

Load Activity File, Gauge004.



12. Determine a function that takes the input from the probe and converts it directly to a signal that positions the servo to the correct number of degrees set by your scale from 20 to 100 degrees.

    w = _____

13. What measurements did you have to make to determine your 'w' function? How was this function created?

