Homework #4
Physics 13BH / CS 15B  Winter 2018

Please read the homework guidelines handout on the course web page.

Before attempting this assignment, ensure your RPi is connected to the Internet, then run the update_physrpi script.

The numbered problems below must be turned in.

Better answers and code will get better grades.

• Read chapters 19–20 and the material about printf from chapter 21 in Shotts.

1. Google “Michele Dufault” and explain what you need to do in order to avoid her misfortune. Note that loose clothing could easily cause a similar problem.

2. In the lab cabinet there are two gelato containers labeled “R” and “C”. Choose, at random, one component from each container. Keep these until you have gotten your homework score from the TAs.
   a. Using your DAC and ADC, measure the RC time constant of the pair. How does your measurement compare with what you expect based on the nominal component values? Turn in your code and a plot of your data.
   b. Assemble this circuit with your resistor and capacitor:

```
    V_in    |     R     |
         |           |
         |     C     |
         |           |
     V_out
```

Use the DAC to set $V_{in}$ to $+3.3\ \text{V}$. Wait at least 5 time constants, then measure $V_{out}$. 
Explain the difference. Which do you think is more important, the ADC input resistance or the capacitor insulation resistance? Hints: You can short out the resistor to see the difference more exactly. Also, see the ECQV capacitor datasheet.

3. Using code from dacdemo.py, write a program with an infinite while loop that generates a 25 Hz sine wave at your DAC output (you can break out of the program with <Ctrl>-C). The output should be 2.0 V peak-to-peak (1.0 V amplitude), centered about +1.0 V. Your program should update the voltage as fast as it can, with as little code as possible in the loop. Use the time.perf_counter() function to measure time, and math.sin() to compute voltages.

   a. Examine your output using an oscilloscope. How frequently is your DAC updating the voltage?

   b. While your program is running, open several browser windows playing Youtube videos. How does this affect your voltage output?

   c. Rewrite your code so that it uses precomputed values instead of calling the sine function from within the loop. The frequency should still be approximately 25 Hz, but need not be exact. How frequent is the voltage update now?

   d. Rewrite your code so that it no longer calls the setV() function, but instead sets the voltage using a direct call to dac0.set_voltage() from inside the loop. How does this change affect the update interval?