Homework #2
Physics 13BH / CS 15B   Winter 2018

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For all sections: due Friday, February 2, at 11:55 p.m.

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 5–8, 15, and the material on tar and rsync from chapter 18 in Shotts. You may skip the sections about floppy disks and CD-ROMs in chapter 15, but do read about dd.

1. Using the datasheets from the course web page, answer the following questions:

   a. Given that we are powering the ADC1015 board with $V_{DD} = 3.3$ V, what is the maximum voltage with respect to ground that you can apply to the analog inputs?
   b. What is the maximum current you can draw from the output of the MCP4725 DAC?
   c. The MCP4725 has rail-to-rail output, and we are supplying it with $V_{DD} = 3.3$ V. Assuming we have set the output voltage to its maximum possible value, what is the minimum resistive load between the output and ground that will ensure a safe output current?
2. Using resistors from the lab, assemble this voltage divider circuit on your breadboard:

\[ \begin{array}{c}
V_{\text{in}} \quad R_1 \quad V_{\text{out}} \\
R_2 \\
\end{array} \]

Choose values for the resistors that will ensure no more than 1 mA of current if \( V_{\text{out}} \) is disconnected and \( V_{\text{in}} \) is set to +3.3 V.

Connect the divider’s \( V_{\text{in}} \) to the MCP4725 VOUT, and connect the divider’s \( V_{\text{out}} \) to the A2 pin on the ADS1015. Ground the A3 pin on the ADS1015.

a. Calculate the output voltage of your divider circuit for inputs of 1.1 V, 2.2 V, and 3.3 V.

b. Using the dacdemo.py and adcdemo.py programs, measure the output of the voltage divider circuit for the three input voltages listed above.

c. Quantitatively explain any differences you see between your predictions and the measurements. Use any necessary error propagation, and take account of the discrete nature of the DAC output and ADC input, and the tolerances of your resistors. What is the largest source of error?

3. Remove any existing connections to your ADS1015 inputs. Get a solar cell from the lab and connect the positive output lead to the A2 input of the ADS1015. Ground the A3 input and the negative lead from the solar cell.

a. Using the fastadc.py program, measure the solar cell output for 2.0 s while it is exposed to the room lights. Turn in an EPS plot of the signal. What is the dominant frequency of the flicker you observe in the signal?

b. Copy the fastadc.py program to a new file named veryfastadc.py. Edit the new program and change the sample rate from 920 per second to 3300 per second. Run the new program and take note of the elapsed time for the measurement. Can you trust the data? Examine the code and try to explain what happened.