Homework #7

Physics 129   Spring 2022

Problems due **Saturday, May 14, 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.

Better answers and code will get better grades.

Reading

- Complete by **Monday, May 16**

- Read sections 10.1.3 and 10.4 in K&N.

Problems

1. **Project specification.** Create a specification and work plan for your class project. This should be a text file including:

   a. the approved version of your 1-paragraph description

   b. a list of the hardware necessary for your project (in addition to a RPi)

   c. a list of the pre-written software components you will need to use in addition to the standard Linux/Python installation on your RPi

   d. a detailed description of the software you will write for the project

   e. a list of tasks necessary to carry out the project, including a target completion date for every task

   Turn in this problem in the usual way, and in addition, for this problem only, **email the text file to Prof. Lipman before the problems in this homework set are due.**

2. **Stripchart.** Modify the example program `stripchart.py` to produce a continuously running plot of $\sin(\omega t)$ vs. t, with $\omega = \pi$ rad/s.

3. **Temperature Stripchart.** Modify your program from the previous stripchart problem so that it displays the current temperature measured by the MCP9808.

4. **Acquire and Store Data.** Write a program that acquires one second of voltages from your solar cell at a rate of 920 samples per second.

   a. Turn in an EPS plot of the data.

   b. Have your program write the data to disk as a text file containing one voltage per line. Turn in this data file.

   Hints: See the `fastadc.py` example program.
   Wave your hand over the solar cell to make the data more interesting.

5. **Fourier Analysis.** Find a light source with periodic intensity, for example a dimmable LED flashlight, a dimmable phone light app or screen, or a fluorescent room light (some fluorescent lights will work, but others will not).

   a. Using your solar cell and the program you wrote for the previous problem, record the light from this source. Turn in the data file.

   b. Write a new program that reads the data into a Numpy array from the disk file and computes the power spectrum of the signal using `matplotlib.mlab.psd()` or functions from `numpy.fft` .

   c. Turn in an EPS plot of the power spectrum, and use it to identify the fundamental frequency at which the light intensity varies.

   Hints: See the `psd_spectrum.py` and `fft_spectrum.py` example programs.
   You may find it necessary to suppress the zero-frequency (DC) component of the power spectrum.

6. **Heat Transfer.** Modify the program you used in the previous two problems so that it acquires and saves temperature data from your MCP9808 at a rate of 4 samples per second.

   a. Heat or cool the sensor and record data as it returns to room temperature. Turn in an EPS plot of the raw data.

   b. Manually select the portion of the data that contains only the heating or cooling curve, and fit the data to an exponential function. You can do this manually by trial and error, or with the appropriate Python functions. Determine the time constant of the exponential, and turn in an EPS plot showing the selected data with the fitting function. Plot the data and fit in different colors.