ME 701 – Development of Computer Applications In Mechanical Engineering
Homework 4 – Due 10/6/2017

Instructions: Your solutions to the following should be contained in one file named `lastname_firstname_hw3.py` and uploaded to Canvas.

Problem 1 – Basic Regular Expressions

Define a regular expression that matches all of the items in the left column but none in the right column:

pit	pt
spot	Pot
spate	peat
slap two	part
respite	

Problem 2 – More Complex Regex

Consider the file `regex_sample_mcnp.txt` (in the examples folder). There are two blocks of text in that file that look like

```
 1tally       18        nps =       10000
+                                    GOOD COUNTS
           tally type 8    pulse height distribution.                  units   number
           particle(s): heavyions

 cell  10
      energy
    0.0000E+00   0.00000E+00 0.0000
    3.0000E-01   0.00000E+00 0.0000
    2.0000E+02   3.35200E-01 0.0141
      total      3.35200E-01 0.0141
```

Use regex to process the file and produce a dictionary of the form

```
1  d{18: {'energy': [0, 3e-1, 2e2], 'value': [0, 0, 3.352e-1], 'sigma'=[0.0, 0.0,
       0.0141]},
2    28: {... so on and so forth
```

Here, 18 and 28 are integer identifiers for particular results of interest (called a "tally"). The energy, value, and uncertainty arrays are the corresponding numerical data.

Problem 3 – Regression

Go out and find some interesting data for which a suitable model has been (or could be) defined. Use that data and the tools presented in class to determine the coefficients to that model that produce the (1) least-squares and (2) minimax fit.

Note, you are all smart engineers, so I assume you can find interesting data. If you can't, some possible options are

- Getting atomic mass data and generating the coefficients to the semi-empirical mass formula.
- Acquiring (maybe even from an MNE faculty member) some measured thermal-hydraulic measurements used to define a correlation (like Dittus-Boelter, etc.)

These models can be linear or nonlinear, but they should not be trivial.

Problem 4 – ODEs

Use SciPy to solve the following:

1. $y' = y + 1$ for $y(0) = 1$ and $t \in [0, 10]$.
2. $y''' = y - y'$ for $y(0) = y'(0) = y''(0) = 1$ and $t \in [0, 10]$.
3. $y' = 1000y + 1$ and $z' = 0.0001z + 1000y$ for $y(0) = z(0) = 1$ and $t \in [0, 10]$.
4. $y' = y^2 + 1$ for $y(0) = 1$ and $t \in [0, 10]$. How would you apply good-old Euler's method to this problem? Do it!
5. $-y'' + y = 1$ for $y(0) = y(10) = 1$. This is a BVP! Look up the "shooting method" or `bvp_solver`.