Winter, 2007

Physics 780.20: Assignment #4

These exercises are follow-ups to class tasks using various GSL functions. Please ask questions! It is due at the end of the day (midnight) on Wednesday, February 28. Note: Your projects will be due by midnight on Thursday, March 15. It is recommended that you turn in something earlier to get feedback while there's time for corrections.

To "hand in" the assignment, upload to Carmen a zip archive of your program files (with the answers to any questions in the comments) and postscript files of any plots. Use C++ and any plotting program you want (gnuplot is recommended). *Check the 780.20 webpage for suggestions and hints.* Please give feedback early and often.

1. Please send email to furnstahl.1@osu.edu by March 3 with a (brief!) progress report on your project. In particular, include a description of your project goal and a list of possible subgoals. Subgoals are things like: write a test code, convert a code from a different language, do an error analysis, etc. The project for 780.20 can be a piece of a bigger project (that doesn't have to be completed this quarter) or can be self-contained. You are free to adjust the project goal and subgoals as you proceed, but I want to have a rough idea where you're heading before it's due!

2. **Cubic Splining.** Your goal is to carry out slighly modified versions of steps 3 and 4 of the Cubic Splining task from Session 9.

   (a) Modify the `spline_function2` code so that it splines the ground-state hydrogen wave function (in the units we've used before):

   $$u(r) = 2r\,e^{-r} \ .$$

   (You can delete the second spline in the code.)

   (b) Determine how many (equally spaced) points to use to represent the wave function. Suppose you need the derivative of the wave function to be accurate to 10^{-6} for $1 < r < 4$ (absolute, not relative error) Devise (and carry out!) a plan that will tell you the number of points needed to reach this goal. [Hint: Think about a graph you could make.]

3. **Nonlinear Least-Squares Fitting with GSL Routines.** Your goal is to carry out parts 4 and 5 of this task from Session 10 (see the guide). Be sure to answer all the questions in part 4. You may have already completed the first three parts of this task, which give you a good start on parts 4. and 5. If you haven't, go through them first.

4. (BONUS) Write a code that reads in the $x(t)$ vs. t data generated by diffeq_oscillations.cpp or diffeq_pendulum.cpp and finds the power spectrum. You can use the fourier.c code from Landau and Paez (available from the 780.20 web page in the "Computer Codes and Makefiles" section).