Winter, 2009

Physics 780.20: Assignment #2

This assignment is a follow-up to Sessions 3 and 4. It is intended to give you additional practice in the basic tasks from class (like coding algorithms), that we'll need repeatedly and build upon, and to verify to me that you can do them. Please ask questions! It is due at the end of the day (midnight) on Friday, January 30.

To "hand in" the assignment, email me (at `furnstahl.1@osu.edu`) a zip archive (see below) with your makefiles and programs (with the answers to any questions in the comments at the top) and a postscript file of the log-log plot. Use C++ and gnuplot. Comment your codes with your name, etc., as in the sample codes from class. *Check the 780.20 webpage for suggestions and hints.* Please ask questions and give feedback early and often.

The problems here are really all parts of the same computational problem of calculating integrals. You can combine them in any way that is convenient (i.e., you don't need separate main programs for each sub-section). Note that the session notes have lots of help info and that a sample code for GSL integration is included in the session 4 zip archive.

1. **Follow-up/Completion of Session 3**

   (a) Write routines to do integration of any given function over a given (finite) interval in double precision using Simpson's rule, the Milne integration rule (see Table 4.1 on page 48 of the Landau/Paez handout on integration), and an appropriate integration routine from the GSL. (If you want, you can base your Simpson's rule routine on the one from class, but note that the interval is not general in that one — it assumes that zero is the lower limit. You might want to check the hints for other suggestions.) Test your routines with a suitable test integral (*choose an integrand we haven't used yet*). The test program and routines should be in separate files and you should use make a project to compile them.

   (b) Write a main program that calls your routines to do part 4. of Section 4.8, "Assessment: Empirical Error Estimate" in the Landau/Paez handout for an integrand of your choice (but not the one in the book!) with the Milne integration rule. The table they want can just be an output file from your code.

   (c) Find *graphically* (i.e., by using a plot) the optimum number of points to use for the Milne integration rule in double precision and show that this makes sense analytically.

   (d) (BONUS) Evaluate one of the singular integrals from the handout (1094 Session

3) directly using Simpson's or Milne and a GSL routine, and then compare to the answer found by applying a method discussed in the handout or session notes (or in Numerical Recipes).

2. How would you analyze your integration results if you didn't know the exact answer? Use the method from the section on "Empirical Error Analysis" from the Session 4 background notes to analyze one of the integration rules (your choice of rule and integral!) to find the approximation error.