PHYSICS 133
IN CLASS ASSIGNMENT FOR THE THIRD CLASS PERIOD

Please bring your laptop or notebook computer with you to class. You need to be able to use it to program and make plots, in the language/utility of your choice. Those who have no prior programming experience will use Microsoft Excel, or if need be, the Open Office equivalent. While I now have enough experience in Excel (I hope!) to support you in completing this task in class, Open Office would be a little more of a wild-card. For any other language (other than Fortran), expect to be largely on your own, although we will be able to provide support for questions that don't have to do with the technical aspects of your chosen language/utility.

While there is no penalty for not completing this exercise, and it will not be graded, it will likely be much easier to complete the follow-on homework if you complete this in class.

Goal

To use the 'inverse transform' technique to generate random numbers according to an exponential distribution, and then to throw and histogram (make a frequency distribution of) a large number of such random numbers.

Background

For certain functions, such as the exponential distribution, the 'inverse transform method' can be used to transform a distribution of random numbers with a uniform ('flat') probability within the intervnal [0,1] (the output of the typical random-number generator) into a set of random numbers distributed with a probability given by that function. (Specifically, the set of function are those whose indefinite integrals are invertible, although you need not know that!). The exponential function

$$f(x) = \frac{1}{\lambda} e^{-x/\lambda}$$

is one such function. If a set of numbers u_i is chosen randomly according to a flat distribution between 0 and 1, then the set of numbers

$$f_i = -\lambda \log(1 - u_i)$$

will be chosen randomly according to an exponential distribution with characteristic length λ.

Procedure

Step 1: Using the methods of calculus, find the average value of the exponential distribution in terms of the parameter λ.

Step 2: Using whatever program you wish, throw 100 random numbers distributed according to an exponential distribution with $\lambda = 10$.

Step 3: Evaluate the average, standard deviation, and error on the mean for this set of numbers. Make a statement as to how consistent your average is with the expectation of Step 1.

Step 4: Make a sensible plot (electronically!) of the resulting exponential distribution. For this you will want to make a 'histogram' (frequency distribution) with sensible bin sizes. The axes should be labeled appropriately. Do not hesitate to ask me or the TA about what is meant by this if it's not clear.