(10 points)

Computing π

The German mathematician Leibniz discovered the rather remarkable fact that the mathematical constant π can be computed using the following mathematical relationship:

$$\frac{\pi}{4} = 1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \frac{1}{11} + \cdots$$

The formula to the right of the equal sign represents an infinite series; each fraction represents a term in that series. If you start with 1, subtract one-third, add one-fifth, and so on, for each of the odd integers, you get a number that gets closer and closer to the value of π/4 as you go along.

For this computer assignment, you are to write a C++ program to get an approximate value for π for a given number of $N \geq 1$ terms in the above series. Your program should prompt and get the value of N from the stdin. Your program is supposed to work for any given value of N, but for a final run, use $N = 1,000,000$.

In addition to the main ( ) routine, add the following subroutine in your program:

> double add_terms (unsigned n): This routine adds the first N terms of the above series and returns the computed sum to the main ( ) routine.

Programming Notes:

- You are not allowed to use any I/O functions from the C library, such as scanf or printf. Instead, use the I/O functions from the C++ library, such as cin or cout.

- Name your source file as prog1.cc and your header file as prog1.h. Guard the statements in your header file using the following format. (This is necessary because you don't want the statements in your header file are processed more than once.)

  #ifndef A-CONST-VALUE // should not be defined any place else
  #define A-CONST-VALUE // same const value as for ifndef directive above

  // put all statements for your header file here

  #endif

- Include all system header files that you need in your program in your header file. For example, to gain access the iostream library, which defines a set of I/O operations, insert the line: #include <iostream> in your header file, and at the top of your file, insert your header file by the following line: #include "prog1.h".

- To compile and link the object file of your program with the system library routines, execute: Make N=1 (assuming you have a link to the script Make in directory: ~cs501/bin from your bin directory). To test your program, execute: Make execute N=1. This command executes your program with the input file prog1.d and displays the output both on the terminal screen and in the output file prog1.out. After you're done, you don't need the object and executable files any more. To delete them, execute: Make clean.

- You can find all related files of this computer assignment in directory: ~cs501/progs/18f/p1. For example, to display the contents of the output file prog1.out, execute the following two commands in sequence, where the first command needs to be executed only once: ln -s ~cs501/progs/18f/p1/prog1.out; cat prog1.out.

- Submit your source and header file to your TA, executing: mail_prog.501 prog1.cc prog1.h.