CS 100 Spring 1998
Assignment 4
"Loops"

Due: *at the end of lecture Tuesday February 24. Assignments will not be accepted late*

In this assignment we will be writing a number of relatively straightforward programs, some of which will be elaborated upon in later assignments. This time you should restrict yourself to the use of "while" and "if" or "if/else". We will also start to write our programs from scratch, though you should feel free to consult your earlier assignments and the textbook for help and encouragement. In all these exercises, you should simply use the standard stationery, and write all your programs in `main` without the use (this time) of other classes.

1. Two gentle warm-ups:

   (i) Write a function to *return* the value of multiplying together all the integers from n down to 1 (this is called the *factorial* of n). The function declaration should be

   ```
   int factorial(int n)
   ```

   Use this function by writing a program to print out the phrase (nine times)

   The factorial of   is equal to   .

   (with the gaps filled in by the appropriate values) once for each number n from 2 up to 10.

   (ii) Write a program to calculate and print the average of all the multiples of 3 from 3 up to (and including) 33333.

2. An integer is given in (the usual) decimal form between 0 and 999999, so for example,

$$46257 = 4(10^4) + 6(10^3) + 2(10^2) + 5(10^1) + 7(10^0).$$

Write a program to convert such a number into binary form (see Lewis/Loftus, appendix B, pp. 581–587). (You will probably want to print out the answer as a succession of single integers next to each other followed by a new line. The program could be done either by repeated subtraction of the highest powers of 2 (binary) which go into the number (keeping track of the number of times this happens for each power), or by careful use of integer division and remainder.) Try this program on several numbers of your choice, including the decimal numbers 648 and 46257.

3. A sequence of numbers $x_1, x_2, x_3, \ldots, x_n, \ldots$ is given by

$$x_n \;=\; 2\,x_{n-1} \;-\; 3\,x_{n-2}$$

where $x_2 = 1$ and $x_1 = 0$. (So for example,

$$\begin{aligned}
x_3 &= 2 \times 1 \;-\; 3 \times 0 \;=\; 2,\\
x_4 &= 2 \times 2 \;-\; 3 \times 1 \;=\; 1,\\
x_5 &= 2 \times 1 \;-\; 3 \times 2 \;=\; -4,\\
x_6 &= 2 \times (-4) \;-\; 3 \times 1 \;=\; -11,\\
x_7 &= 2 \times (-11) \;-3\; \times (-4) \;=\; -10,\\
x_8 &= 2 \times (-10) \;-\; 3 \times (-11) \;=\; 13, \quad \text{etc..})
\end{aligned}$$

Write a program to calculate x_{100}. (You will want to have a `while` loop in which n is incremented, and will probably find it easiest to have three integer variables (e.g., `x, xbackone, xbacktwo`) inside the loop to allow for the shuffling of x–values. Also, you will find it helpful to write out a few steps by hand to be clear about how the variable names adopt their values.)