**Name:**

**Advanced Programming in C++**

**Lab Exercise 4/12/2023**

In this lab exercise, you will write several programs that involve solving some very relevant problems that you will encounter in the future.

1. Create a digital computer differentiator. A differentiator is a fancy name for the instantaneous slope of a function. Here is some code that will implement this. Unfortunately, it is written in Dartmouth Basic (a variant of BASIC developed at Dartmouth College in 1964 by Professors Kemeny and Kurtz). Historical Note: The BASIC (Beginners All-purpose Symbolic Instruction Code) was derived from an earlier language DOPE (Dartmouth Oversimplified Programming Experiment).

5 REM BASIC DIFFERENTIATOR

10 DEF FN X(T) = 5 \* T^2

20 INPUT “ENTER VALUE OF T “; T

30 INPUT “ENTER VALUE OF DELTA T “; DELTA

40 X1 = FN X(T)

50 X2 = FN X(T + DELTA)

60 DELTAX = X2 – X1

70 XDOT = DELTAX / DELTA

80 PRINT (“THE DERIVATIVE IS “; XDOT

90 END

1. Create a basic computer integrator. An integrator is a fancy name for calculating the area encompassed by a function. Here is some code that will implement this. Unfortunately it is also written in Dartmouth Basic.

5 REM BASIC INTEGRATOR

10 DEF FN X(T) = 10 \* T^2

20 INPUT (“ENTER VALUE OF UPPER LIMIT “; T2

30 INPUT (“ENTER VALUE OF LOWER LIMIT “; T1

40 INPUT (“ENTER NUMBER OF INTEGRATION STEPS “; N

50 DELTA = (T2 – T1) / N

60 SUM = 0 : T = T1

70 FOR I = 0 TO N

80 SUM = SUM + DELTA \* FN X(T)

90 T = T + DELTA

100 NEXT

110 PRINT “THE VALUE OF THE INTEGRAL IS “; SUM

120 END

1. Triangular numbers (so called because they can be arranged in a triangle are the sum of the n natural numbers from 1 to n. The nth triangular number is given by the formula:



For example, 15 is the 5th triangular number T5 since 1 + 2 + 3 + 4 + 5 = 15.

Write a program that will test a number to see it is triangular. If it is, print the number as a triangular output. For example, since 15 is triangular it should print out as such

X

XX

XXX

XXXX

XXXXX

Solve these problems and turn in your source code and a sample output attached to this sheet.

**4. Factorial Challenge**

Write a program that determines the number of trailing zeros at the end of X! (X factorial), where X is an arbitrary number. For instance, 5! is 120, so it has one trailing zero. (How can you handle extremely values, such as 100!?) The input format should be that the program asks the user to enter a number. Hint: To find the number of trailing zeros, count the number of multiples of 5 there are in the number you are taking the factorial of. For example, 100! Has 20 multiples of 5 (5, 10, 15, 20 … 95, 100). Be sure to write your program to handle the factorial of any integer.

**5. Dual Primes**

A dual prime is 2 prime numbers that are exactly “2” apart. Example: 3, 5 // 11, 13, etc.

In his challenge you will do the following things:

Create a program that will:

* Allow a user to input a number to iterate up to
* Allow the user to see all the dual primes, and a list of the numbers that are NOT dual prime

**6. Day of Year**

Write a program that, given a date, three ints (for example, 11 27 1997), will print the number of that day within its year: i.e. Jan 1st is always 1, Dec 31st is either 365 or 366.

**7. How Old are the Doritos?**

The law requires that food product manufacturers place expiration dates on their products, but there is a loophole in the law: it does not require the expiration date to be in any particular form. So, it can be written in Swahili and still be legal.

Ralph Nader's third cousin, Nadine is a self-appointed Food Quality Spy. She has learned that many food product manufacturers have started encoding the product expiration dates to keep customers from knowing how old the stuff is.

But the encoding does allow grocers to figure out the expiration dates if for some reason, they want to.

One popular encoding method:

* encode the months from Jan to Dec as 'A' through 'L'
* encode each digit of the date as 'Q' through 'Z'
* encode the year as 'A' through 'Z' meaning 1 through 26 which is then added to 2000.

Nadine found a particularly questionable loaf of bread with this date: ARZM. Write a program to determine the date.