NATIONAL UNIVERSITY OF COMPUTER & EMERGING SCIENCES
ISLAMABAD CAMPUS

CS-1002 Programming Fundamentals Fall-2022

ASSIGNMENT- 03 (LOOPS)
Section (A, B, C, D, E, F, G, H, J and K)

Submission Information

Submission Deadline: **November 1, 2022 4:00 PM**. You are supposed to submit your assignment on GOOGLE CLASSROOM (CLASSROOM TAB not lab). Only ".ZIP" files are acceptable. Other formats will be directly given ZERO. Correct and timely submission of the assignment is the responsibility of every student, hence no relaxation will be given to anyone. Late submission policy will be applied as described in course outline.

Tips: For timely completion of the assignment, start as early as possible.

Plagiarism: Plagiarism is not allowed. If found plagiarized, you will be awarded zero marks in the assignment (copying from the internet is the easiest way to get caught).

Instructions:

Dear students, we will be using auto-grading tools, so failure to submit according to the format below would result in zero marks in the relevant evaluation instrument.

- For each question in your assignment, make a separate cpp file e.g. for question 1, make ROLL-NUM_SECTION_Q#.cpp (22i-0001_A_Q1.cpp) and so on. Each file that you submit must contain your name, student-id, and assignment # on top of the file in comments.
- Combine all your work in one folder. The folder must contain only .cpp files (no binaries, no exe files etc.).
- Run and test your program on a lab machine before submission.
- Rename the folder as ROLL-NUM_SECTION (e.g. 22i-0001_A) and compress the folder as a zip file. (e.g. 22i-0001_A.zip). Do not submit .rar file.
- Submit the .zip file on Google Classroom within the specified deadline.
- Submission other than Google classroom (e.g. email etc.) will not be accepted.
- The student is solely responsible to check the final zip files for issues like corrupt file, virus in the file, mistakenly exe sent. If we cannot download the file from Google classroom due to any reason it will lead to zero marks in the assignment.
- Displayed output should be well mannered and well presented. Use appropriate comments and indentation in your source code.
- Total Marks:

Learning Objective

The AIM of this assignment is to have hands-on topics such as LOOPS and NESTED LOOPS.
Warning:

- For this assignment, you are not allowed to use advanced topics including array, vectors, etc.Otherwise, no marks will be awarded.
- If there is a syntax error in the code, zero marks will be awarded in that part of the assignment.
- Your code must be generic.
- Follow the given instruction to the letter, failing to do so will result in zero marks.

<u>Problem 1:</u> A high school has 1000 students and 1000 lockers, one locker for each student. On the first day of school, the principal plays the following game: She asks the first student to go and open all the lockers. She then asks the second student to go and close all the even-numbered lockers. The third student is asked to check every third locker. If it is open, the student closes it; if it is closed, the student opens it. The fourth student is asked to check every fourth locker. If it is open, the student closes it; if it is closed, the student opens it. The remaining students continue this game. In general, the nth student checks every nth locker. If the locker is open, the student closes it; if it is closed, the student opens it. After all the students have taken their turn, some of the lockers are open and some are closed. Write a program that prompts the user to enter the number of lockers in a school. After the game is over, the program outputs the number of lockers that are opened. Test run your program for the following inputs: 1000, 5000, 10000. Do you see any pattern developing?

(Hint: Consider locker number 100. This locker is visited by student numbers 1, 2, 4, 5, 10, 20, 25, 50, and 100. These are the positive divisors of 100. Similarly, locker number 30 is visited by student numbers 1, 2, 3, 5, 6, 10, 15, and 30. Notice that if the number of positive divisors of a locker number is odd, then at the end of the game, the locker is opened. If the number of positive divisors of a locker number is even, then at the end of the game, the locker is closed.)

<u>Problem 2:</u> When you borrow money to buy a house, a car, or for some other purpose, you repay the loan by making periodic payments over a certain period of time. Of course, the lending company will charge interest on the loan. Every periodic payment consists of the interest on the loan and the payment toward the principal amount. To be specific, suppose that you borrow $1000 at the interest rate of 7.2% per year and the payments are monthly. Suppose that your monthly payment is $25. Now, the interest is 7.2% per year and the payments are monthly, so the interest rate per month is 7.2/12 1⁄4 0.6%. The first month's interest on $1000 is 1000 x 0.006 = 6. Because the payment is $25 and interest for the first month is $6, the payment toward the principal amount is 25 – 6 = 19. This means after making the first payment, the loan amount is 1000 – 19 = 981. For the second payment, the interest is calculated on $981. So the interest for the second month is 981 x 0.006 = 5.886, that is, approximately $5.89. This implies that the payment toward the principal is 25 – 5.89 = 19.11 and the remaining balance after the second payment is 981 – 19.11 = 961.89. This process is repeated until the loan is paid. Write a program that accepts as input the loan amount, the interest rate per year, and the monthly payment. (Enter the interest rate as a percentage. For example, if the interest rate is 7.2% per year, then enter 7.2.) The program then outputs the number of months it would take to repay the loan. (Note that if the monthly payment is less than the first month's interest, then after each payment, the loan amount will increase. In this case, the program must warn the borrower that the monthly payment is too low, and with this monthly payment, the loan amount could not be repaid.)

<u>Problem 3:</u> Suppose that the first number of a sequence is x, in which x is an integer. Define

$a_0 = x$; $a_{n+1}= a_{n/2}$ if a_n is even; $a_{n+1}=3 \times a_{n+1}$ (x means multiply) if a_n is odd. Then, there exists an integer k such that $a_k = 1$. Write a program that prompts the user to input the value of x. The program output the integer k such that $a_{k=1}$ and the numbers a_0, a_1, a_2, . . . , a_k. (For example, if x=75, then k=14, and the numbers a_0, a_1, a_2, . . ., a_{14}, respectively, are 75, 226, 113, 340, 170, 85, 256, 128, 64, 32, 16, 8, 4, 2, 1.) Test your program for the following values of x: 75, 111, 678, 732, 873 2048, and 65535.

Example: Pick some positive integer and call it *n*.If *n* is even, divide it by two. If *n* is odd, multiply it by three and add one. Continue this process until *n* is equal to one.

Starting with the number 15:

15 is odd,so I make 3*n*+ 1 : 46
46 is even, so I take half: 23
23 isodd,so I make 3*n*+ 1 : 70
70 is even, so I take half: 35
35 is odd,so I make 3*n*+ 1 : 106
106 is even, so I take half: 53
53 is odd,so I make3*n*+ 1 : 160
160 is even, so I take half: 80
80 is even, so I take half: 40
40 is even, so I take half: 20
20 is even, so I take half: 10
10 is even, so I take half: 5
5 is odd, so I make3*n*+ 1 : 16
16 is even, so I take half: 8
8 is even, so I take half: 4
4 is even, so I take half: 2
2 is even, so I take half: 1

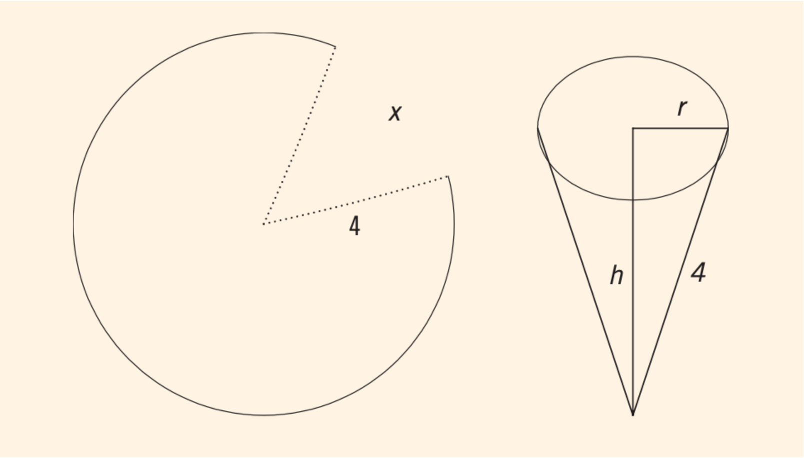
Problem 4: The population of a town A is less than the population of town B. However, the population of town A is growing faster than the population of town B. Write a program that prompts the user to enter the population and growth rate of each town. The program outputs after how many years the population of town A will be greater than or equal to the population of town B and the populations of both the towns at that time. (A sample input is: Population of town A = 5000, growth rate of town A = 4%, population of town B = 8000, and growth rate of town B = 2%.)

Problem 5: Let n=$a_k a_{k-1} a_{k-2} ... a_1 a_0$ be an integer and t=a_0 -a_1 +a_2 -…. + $(-1)^k$ a_k. It is known that n is divisible by 11 if and only if t is divisible by 11. For example, suppose that n = 8784204. Then, t = 4 - 0 + 2 - 4 + 8 - 7 + 8 = 11. Because 11 is divisible by 11, it follows that 8784204 is divisible by 11. If n=54063297, then t = 7 - 9 + 2 - 3 + 6 - 0 + 4 - 5 = 2. Because 2 is not divisible by 11, 54063297 is not divisible by 11.Write a program that prompts the user to enter a positive integer and then uses this criterion to determine whether the number is divisible by 11.

Problem 6: Write a program that uses **while** loops to perform the following steps:

a. Prompt the user to input two integers: firstNum and secondNum (firstNum must be less than secondNum).
b. Output all odd numbers between firstNum and secondNum.
c. Output the sum of all even numbers between firstNum and secondNum.
d. Output the numbers and their squares between 1 and 10.
e. Output the sum of the square of the odd numbers between firstNum and secondNum.
f. Output all uppercase letters between firstNum and secondNum

Problem 7: You have been given the contract for making little conical cups that come with bottled water. These cups are to be made from a circular waxed paper of 4 inches in radius by removing a sector of length x (see Figure 5-4). By closing the remaining part of the circle, a conical cup is made. Your objective is to remove the sector so that the cup is of maximum volume.



Write a program that prompts the user to enter the radius of the circular waxed paper. The program should then output the length of the removed sector so that the resulting cup is of maximum volume. Calculate your answer to two decimal places.

Problem 8: A real estate office handles, say, 50 apartment units. When the rent is, say, $600 per month, all the units are occupied. However, for each, say, $40 increase in rent, one unit becomes vacant. Moreover, each occupied unit requires an average of $27 per month for maintenance. How many units should be rented to maximize the profit?

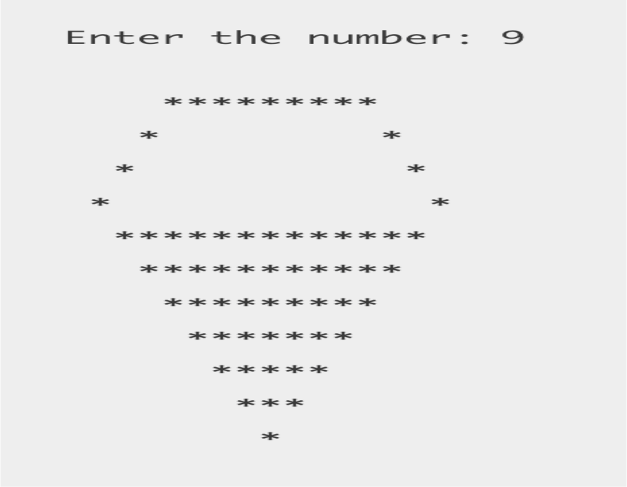
Write a program that prompts the user to enter:

1. The rent to occupy all the units.
2. The increase in rent that results in a vacant unit.
3. Amount to maintain a rented unit.

The program then outputs the number of units to be rented to maximize the profit.

Problem 9: Write C++ programs to print the following patterns.

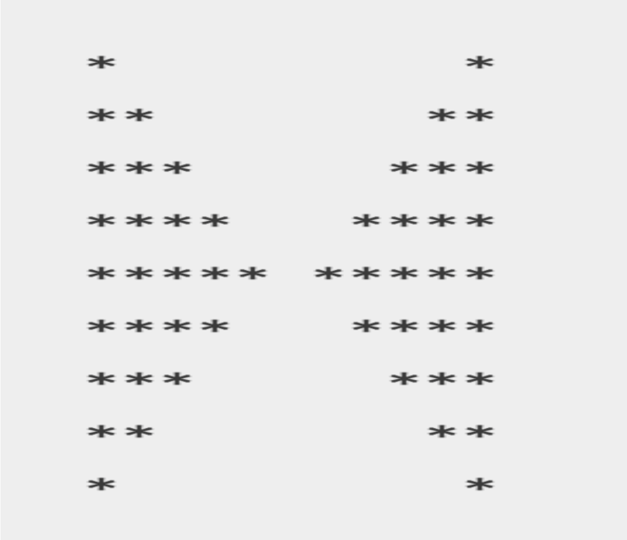
Pattern 1:



```
Enter the number: 9

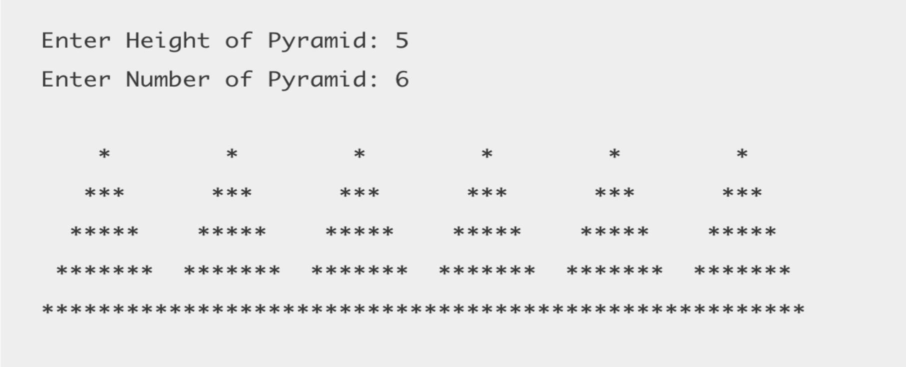
     *********
    *         *
   *           *
  *             *
   *************
    ***********
     *********
      *******
       *****
        ***
         *
```

Pattern 2:



```
*         *
**       **
***     ***
****   ****
***** *****
****   ****
***     ***
**       **
*         *
```

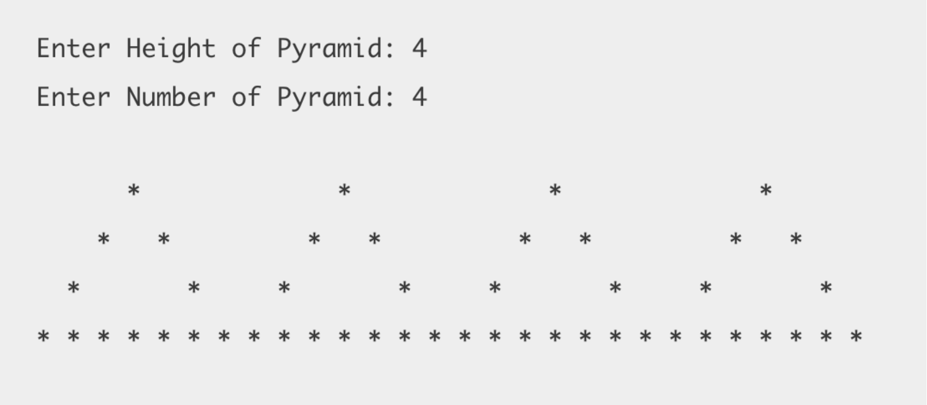
Pattern 3:



```
Enter Height of Pyramid: 5
Enter Number of Pyramid: 6

    *        *        *        *        *        *
   ***      ***      ***      ***      ***      ***
  *****    *****    *****    *****    *****    *****
 *******  *******  *******  *******  *******  *******
******************************************************
```

Pattern 4:



```
Enter Height of Pyramid: 4
Enter Number of Pyramid: 4

      *             *             *             *
    *   *         *   *         *   *         *   *
  *       *     *       *     *       *     *       *
* * * * * * * * * * * * * * * * * * * * * * * * * * * *
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<u>Problem 10:</u> There is island in Japan which is named as Rabbit Island because there is inhabited by hundreds of wild rabbits. The island has become a popular destination for tourists. Rabbit Island was used as a site for producing chemical weapons during the Second World War. It was subsequently abandoned due to health concerns, and no one is sure where the rabbits came from. One theory is that the one pair of rabbits escaped from being tested at the chemical weapons establishment.

Imagine you have a pair of rabbits, one male and one female in a field. Suppose one pair of rabbits breed a new pair after every two months. The new pair will not breed after the first two months.

Start: 1 pair

After 2 months: 1 + 1

Write a C++ program using while Loop that will print how many rabbit pairs we have after **n** months.