CS-1002 Programming Fundamentals Spring - 2023

[Assignment – 03] **[Total Marks 50]**

Question 1:

Binomial coefficients are the coefficients of the terms in the expansion of a binomial expression, such as (a + b)^n. For example, in the expansion of (a + b)^3, the terms are: a^3, a^2b, ab^2, and b^3. The binomial coefficients are the numbers that appear in front of each term: 1, 3, 3, and 1, respectively. The binomial coefficient C(n, k), also known as "n choose k", represents the number of ways to choose k items from a set of n items without regard to order. The formula for calculating the binomial coefficient is:

C(n, k) = n! / (k! * (n - k)!)

where n! is the factorial of n (i.e., n! = n * (n-1) * (n-2) * ... * 2 * 1),

k! is the factorial of k,

and (n-k)! is the factorial of n-k.

Pascal's triangle can be used to calculate the binomial coefficients, which are used in probability theory to calculate the probability of a certain event occurring a certain number of times in a sequence of independent events. For example, if we want to know the probability of getting exactly 3 heads when flipping a coin 5 times, we can use Pascal's triangle to calculate the binomial coefficient for this event.

Pascal's triangle is a triangular array of numbers in which the first and last numbers in each row are 1, and each of the other numbers is the sum of the two numbers immediately above it. The first row of the triangle is just the number 1, and each subsequent row is constructed by adding adjacent pairs of numbers from the previous row.

To calculate the binomial coefficients using Pascal's triangle, we start by writing the first few rows of the triangle:

1
1 1
1 2 1
1 3 3 1
1 4 6 4 1
...

Each row of the triangle corresponds to the coefficients of the terms in the expansion of (a + b)^n, where n is the row number minus 1. For example, the fourth row corresponds to the expansion of (a + b)^3, and the coefficients are 1, 3, 3, and 1.

To find the value of C(n, k), we look at the (n+1)th row of the triangle, and take the kth number in that row. For example, to find C(5, 2), we look at the 6th row of the triangle (since n = 5), and take the 3rd number (since k = 2):

1 5 10 10 5 1
^
kth number

So C(5, 2) = 10.

In general, we can calculate C(n, k) using the following formula:

C(n, k) = (n choose k) = (n-1 choose k-1) + (n-1 choose k)

This formula follows from the fact that to choose k items from a set of n items, we can either choose the first item and then choose the remaining k-1 items from the remaining n-1 items, or we can skip the first item and choose the k items from the remaining n-1 items.

Using this formula, we can calculate the binomial coefficients for any values of n and k, without having to calculate factorials directly.

Your task is to write a C++ program to calculate Binomial coefficients C(n, k) = n! / (k! * (n - k)!) using the Pascal's triangle for a given number of rows using a for loop and nested loops. Also print the Pascal's triangle.

Question 2:

Write a program which prints the following patterns on screen using loops (use of for loop is not allowed).
For input n = 5

Question 3:

A company that sells shoes wants to keep track of their inventory using a computer program. They have a list of their current inventory, which includes a unique numeric code of the shoe, the size, the quantity on hand, and the price. They want to be able to add new items to the inventory, remove items from the inventory, and update the quantity and price of existing items. They also want to be able to display a report that shows the current inventory and the total value (in rupees) of the inventory.

Write a C++ program using loops and 1D arrays that allows the user to perform the following operations on the inventory:

- **[1]** Add a new item to the inventory
- **[2]** Remove an item from the inventory
- **[3]** Update the quantity of an existing item
- **[4]** Update the price of an existing item
- **[5]** Display the current inventory and the total value of the inventory

Question 4:

You are tasked with developing a program for a robotics company that controls a grid of sensors for a manufacturing plant. The sensors are arranged in a 2D array with rows and columns, and each sensor can either be "on" or "off". The program needs to read in data from the sensors and display the information in a user-friendly way.

You need to write a C++ program that reads in data from a 2D array representing the sensor grid, and displays the information in a way that is easy for the user to understand. The program should prompt the user to enter the number of rows and columns in the grid, and then read in the data for each sensor (either "1" for on or "0" for off). Once the data has been read in, the program should display the grid on the screen, with "X" representing an on sensor and "." representing an off sensor. The program should also calculate and display the percentage of sensors that are currently on.

Example output:

```
Enter the number of rows: 4
Enter the number of columns: 6
Enter the sensor data:
1 0 1 0 1 0
0 0 1 1 0 1
1 1 1 0 0 0
0 0 0 1 1 1

Sensor Grid:
X . X . X .
. . X X . X
X X X . . .
. . . X X X

Percentage of sensors on: 47.22%
```

Question 5:

Write a C++ program that can be used by a small theater to sell tickets for performances. The theater's auditorium has 15 rows of seats, with 30 seats in each row. The program should display a screen that shows which seats are available and which are taken. For example, the following screen shows a chart depicting each seat in the theater. Seats that are taken are represented by an * symbol, and seats that are available are represented by a # symbol:

```
        Seats
        123456789012345678901234567890
Row 1  ***###***###*########*****####
Row 2  ####************####*******##
Row 3  **###**********########****###
Row 4  **######**************##******
Row 5  ********#####**********########
Row 6  ##############***********####
Row 7  #######***********###########
Row 8  ***********##*****###########
Row 9  #########*****#############****
Row 10 #####************############
Row 11 #**********##################**
Row 12 #############********########*
Row 13 ###**********########**######
Row 14 ##############################
Row 15 ##############################
```

Here is a list of tasks this program must perform:

- **[1]** When the program begins, it should ask the user to enter the seat prices for each row. The prices can be stored in a separate array.
- **[2]** Once the prices are entered, the program should display a seating chart similar to the one shown above. The user may enter the row and seat numbers for tickets being sold. Every time a ticket or group of tickets is purchased, the program should display the total ticket prices and update the seating chart.
- **[3]** The program should keep a total of all ticket sales. The user should be given an option of viewing this amount.
- **[4]** The program should also give the user an option to see a list of how many seats have been sold, how many seats are available in each row, and how many seats are available in the entire auditorium.
- **[5]** Input Validation: When tickets are being sold, do not accept row or seat numbers that do not exist. When someone requests a particular seat, the program should make sure that seat is available before it is sold.

Question 6:

Instructions.

[1] Submission Format:

[a] You have to solve it on Microsoft Visual Studio. Write your name, roll number, and question number on top of every question program using proper comments. Submit only .cpp file of your program. Question1_Rollnumber.cpp file.

[b] For example (Question1_22I-1234.cpp)

[2] Combine all your work in one folder. The folder must contain **only the .cpp files** as instructed in [1][a].

[3] Rename the folder as Roll-Num_Section_Name (e.g. 22i-1234_A_Ali) and compress the folder as a zip file. (e.g. 22i-1234_A_Ali.zip).

[4] Do not submit .rar file.

[5] Submit the .zip file on Google Classroom within the deadline.

[6] Submission other than Google classroom (e.g. Email etc.) Will not be accepted.

[7] The student is solely responsible to check the final zip files for issues like corrupt file, virus in the file, mistakenly exe sent.

[8] If instructor cannot download the file from Google classroom due to any reason it will lead to zero marks in the assignment.

[9] Deadline to submit assignment is **1st April 2023 11:59 PM.**

[10] Assignment submitted after the deadline will be marked DIRECT ZERO.

[11] You are supposed to submit your assignment on **Google Classroom (Classroom Tab Only, Not Lab).**

[12] Correct and timely submission of the assignment is the responsibility of every student; hence no relaxation will be given to anyone.

[13] For timely completion of the assignment, start as early as possible.

[14] Plagiarism is not allowed. If found plagiarized, you will be awarded zero marks in all the assignments.

NOTE:

[a] Consider the corner cases while programming. What if the user enters any number other than the menu ids, the program should end?

[b] Display appropriate messages where needed. Keep in mind you have to make **software to assist the user**.

[c] Display appropriate table with correct format and styling.