



Assignment 2

Delivery Notes:

- This is a group assignment of 2 members (at most) and the members should be from the same group/lab.
- Both students should work and fully understand everything in the code.
- Due date is on Monday May 24th, 2021 until 11:55 pm
- No late submission is allowed.
- Submission will be on blackboard. It is your duty to ensure that your submission was properly uploaded to blackboard after you finish submitting it. If your submission was not uploaded properly, you will not receive a grade for the assignment.
- No submission through e-mails.
- For each task you will develop a .cpp file that should include a block comment containing students' IDs and names. These files should be named task1.cpp, task2.cpp, task3.cpp and task4.cpp, then put these cpp files in a folder named GroupNum_firstStudentID_SecondStudentID and compress them to a .zip file with the same folder name. The compressed file would be the file to be delivered.
- The allowed values for group numbers in the zip file name is **S1 till S44**, and for the **old ByLaw G1 till G4**. Please check your group number using the student names list uploaded on blackboard because writing it wrong will not allow your TA to receive your assignment and you might lose its grade.
- **Failing to abide by the naming conventions of the file or failing to submit the files as per the requested .cpp extension, would result in a ZERO for both team members.**
- **Do not send your code** to anyone, so that no other student would take your files and submit it under their names.

- **In case of Cheating you will get a negative grade whether you give the code to someone, take the code from someone/internet, or even send it to someone for any reason.**
- You have to write clean code and follow a good coding style including choosing meaningful variable names, and adding comments all through your source code.
- You have to use functions and not write all of the code in the main.
- If the input is not valid the program should not close. The program should notify the user that the input was invalid and allow the user to re-enter the input until a valid input is given.

Problem-1:

[Do not use any built-in functions]

Maclaurin series are a type of series expansion in which all terms are nonnegative integer powers of the variable. Maclaurin series for common math functions include:

$$\cos x = \sum_{n=0}^{\infty} \frac{(-1)^n}{(2n)!} x^{2n}$$

$$\cos x = 1 - \frac{1}{2}x^2 + \frac{1}{24}x^4 - \frac{1}{720}x^6 - \dots \text{ for } -\infty < x < \infty$$

$$\sin x = \sum_{n=0}^{\infty} \frac{(-1)^n}{(2n+1)!} x^{2n+1}$$

$$\sin x = x - \frac{1}{6}x^3 + \frac{1}{120}x^5 - \frac{1}{5040}x^7 + \dots \text{ for } -\infty < x < \infty$$

$$\tan x = \sum_{n=0}^{\infty} \frac{(-1)^n 2^{2n+2} (2^{2n+2} - 1) B_{2n+2}}{(2n+2)!} x^{2n+1}$$

$$\tan x = x + \frac{1}{3}x^3 + \frac{2}{15}x^5 + \frac{17}{315}x^7 + \frac{62}{2835}x^9 + \dots$$

Where x is an angle in radians and B_n is the Bernoulli Number. The first few Bernoulli numbers are listed below. If your calculation demands more Bernoulli numbers, you can calculate them using any online Bernoulli number calculator.

$$\begin{aligned} B_0 &= 1 \\ B_1 &= -\frac{1}{2} \\ B_2 &= \frac{1}{6} \\ B_4 &= -\frac{1}{30} \\ B_6 &= \frac{1}{42} \\ B_8 &= -\frac{1}{30} \\ B_{10} &= \frac{5}{66} \\ B_{12} &= -\frac{691}{2730} \\ B_{14} &= \frac{7}{6} \\ B_{16} &= -\frac{3617}{510} \\ B_{18} &= \frac{43867}{798} \\ B_{20} &= -\frac{174611}{330} \\ B_{22} &= \frac{854513}{138} \end{aligned}$$

Using the above formula, write a program that allows the user to calculate $\sin(x)$, $\cos(x)$, $\tan(x)$. The user should enter the angle in degrees, and then the program should transform it into radians before performing the three requested calculations. For each requested calculation (i.e., $\sin(x)$, $\cos(x)$, $\tan(x)$), you need to calculate the first 15 terms of the series.

Please note that you are not allowed to use any built-in functions (e.g., using functions like `pow(2,3)` is prohibited. You should write your own alternative functions for all the needed calculations).

Problem-2:

[Do not use arrays]

Who wins the vote?

The Egyptian Sewing Syndicate is holding an election to see who will be the next president. There are three candidates Adham, Bilal, and Catherine. Due to controversy during the last elections it has been decided that this year they will try to implement a new voting system next to the old one to see if the results would be different.

Normally in elections only one candidate is given a vote per voter; however, this year in addition to the normal election calculation a point system is to be tried. This means that each voter should give a list of all three candidates in order of preference.

The point system dictates that for each first preference a candidate receives they will be given 3 points, second preference 2 points, and third preference 1 point. The winner of the election will be the candidate with the most votes.

Write a program that first prompts the user to enter names of 3 candidates , & the number of voters in the election. The user should then enter the names of the candidates in order of preference for each voter. The program should then have two calculations: one for the result of the normal majority election and one for the result of the new point system.

Important notes:

- The preferences cannot have any repetitions and the program should detect this and prompt the user to input the preferences correctly.
- The two different calculations should be done in different functions and not directly in the main.
- Implement and make use of the following functions:
 - A function that prints a message to prompt for entering the 3 choices of candidates of 1 voter. (use reference parameters where needed)
 - A function to help with the normal majority election system which that takes a voter's first choice and the 3 current points of each of the 3 candidates and updates one of the points based on the voter's first choice. (use reference parameters where needed)
 - A function to help with the new point system that takes the 3 choices of a voter, and the 3 current points of each of the 3 candidates and updates all of the points based on the voter's choices. (use reference parameters where needed)
 - A function takes the 3 candidate names and the points of each candidate and returns the name of the winner.

Problem-3:

[You may use arrays]

Credit Card Number Validation

Payment card usage in Egypt is on a steady rise. According to the CBE report there are over 22 million active debit and credit cards in Egypt. This means that vendors accepting payments through these cards need to have a way of validating the card numbers before attempting to process the payment.

Luckily there is a systematic way to validate card numbers.

1. First verify the number of digits is valid (between 14 and 16)
2. Starting from the right multiply each second digit by 2. If the result of the multiplication is more than 1 digit add the digits together until you have a single digit.
3. Sum the digits from the previous step.
4. Sum the digits that had not been multiplied by 2 in step 2
5. Add the results from step 3 and 4 together
6. If the result is divisible by 10 then the number is valid

Write a program that takes a credit card number as input and checks its validity.

- Implement and make use of the following functions:
 - A function that takes a card number and returns its validity (true/false)
 - A function that takes a card number and calculates the sum described in points 2 & 3 above.
 - A function that takes a card number and calculates the sum described in point 4 above.
 - A function that takes an integer and returns it as it is if it's a single digit, otherwise it returns the sum of the 2 digits.

Problem-4:

How much to refund on your employee's business trip?

As a business owner you have sent an employee on a business trip. Upon their return you feel that the employee has spent too much money and should not be refunded the entire amount of money that they had spent since you feel that not all of it was business related. You ask your HR department to create a business trip refund policy that is fair.

The HR department responded with a list of things that should be calculated in order to get a fair number. Write a program that calculates the refund amount of the business trip by creating functions that ask for and returns the following:

- How many days were spent on the trip
- At what time did the employee depart on the first day of the trip, and the at what time did the employee arrive back home on the last day of the trip
- How much did the plane tickets cost (if travelling by plane)
- If the employee rented a car how much did they pay
- If the employee used their own vehicle refund 0.775 EGP per kilometer that they drove
- Parking fees (The maximum allowed is 25 EGP per day)
- Taxi fees (The maximum allowed is 100 EGP per day, for each day a taxi was used)
- Entry fees to any conference or seminar (if applicable)
- Accommodation (The maximum allowed is 500 EGP per day)
- The cost of each meal.
- On the first day breakfast is allowed if departure is before 8 am. Lunch is allowed if the departure is before 12 pm. Dinner is allowed if the departure is before 6 pm.
- On the last day breakfast is allowed if the arrival is after 9 am. Lunch is allowed if the arrival is after 1 pm. Dinner is allowed if the arrival is after 7 pm.
- The employee will only be refunded for applicable meals with a maximum of 40 EGP for breakfast, 60 EGP for lunch and 80 EGP for dinner.
- You need to calculate the total expenses paid by the employee (not including non-permissible meals) and calculate the total refund amount.
- You need to calculate the total expenses that were rejected for refund by the system. For instance, if the parking was for 30EGP and he got refunded for 25 EGP, and the Accommodation was for 550 EGP, and he got refunded for 500 EGP only, the rejected expenses should be $5 + 50 = 55$ EGP.
- Input Validation:
 - Do not accept negative numbers for money values.
 - Do not accept negative numbers for km driven.
 - Do not accept numbers less than 1 for the number of days
 - Only accept valid times for the time of departure and the time of arrival.

Grading (100 points).