Task One: Design Patterns

Read and Study the Following Study Case, and Detect the best Design Patterns to Implement it. Explain why you chose these Design Patterns, is there an alternative for any of them? Why? Why did you choose the one you chose?! Draw the Class Diagram for the Study Case regarding the Design Patterns you used.

Note, you may need to design more than one class diagram. Anyway, it is your choice.

HRMS is a **H**uman **R**esources **M**anagement **S**ystem, which is responsible for tracking the Employees of different departments in a company and saving their data into a Reliable and Secured Database.

Users of the System are Separated into Manager, Head of Department and Employee, each of them has a different Privilege.

Let there is a user called "Visitor" has some privileges on the system, like visiting public pages of the system, while other privileges (or pages) will be available only if he becomes an authorized one (either Employee, Head of Department or Manager).

The System enables the admin to print the data of all Employees, and gives him two different ways for showing the data.

- First: Alphabetical Order, no matter the department or the type of the employee.
- Second: in a tree shape that describes the Hierarchal Structure of the Company.

The Manager needs to make some complex operations on a specific Employee (Given the id or the name as an input). One of these operations is “Getting the Evaluation”, which helps the Manager to make a decision on him. The Evaluation passes through many operations, get the total Duration that the employee has worked, number of days he was absent. These two Operations happen for **all** Employees.

- If the Employee is from the Financial Department, then the system Calculates the Total values of the deals that he closed for the company.
- If he is from the Technical Department, then the system calculates how many Systems he worked on

- and so on for every department.

Each Department has a specific attribute that must be considered (the total values of deals, how many systems he worked on, etc..). Some Departments have **extra** operations that are needed to be executed, but **only** in these departments. In the end, all these operations are combined together in the **same** order and the **same** way, to get the Final Evaluation Report.

Every Employee can be concerned of some aspects of the company, some are concerned of the New Partnerships, new Trainings, new Projects, or any other things. Some of them are Concerned to know about more than one thing. Thus, the system should notify them when their interests have something new.

Some Operations are very complex, that they are consist of so-called "mini operations", the Manager needs to make these operations many times in the system. For example:

- The Manager needs to hold a meeting:
  - ✓ The System determines the suitable time for all Employees
  - ✓ Add the meeting on the Schedule for them
  - ✓ notify them
  - ✓ Prepare the Meetings Room

Task Two: Problem Sets

Problem Solving helps you to pass many Questions in the Interviews, and is a good way to test your Critical Thinking and Algorithms and Data Structure Knowledge. Study these Problem Sets, and find the best Solution for them. Implement them in any Programming language (C++ and Java are Preferable but not excluded), try to avoid the Built-in functions and consider calculating the Big O Notation for every Problem.

1. Given a string, write a function to check if it is a permutation of a palindrome. A palindrome is a word or phrase that is the same forwards and backwards. A permutation is a rearrangement of letters. The palindrome does not need to be limited to just dictionary words.

   Example: Input: Tactcoa

   Output: True (permutations: "tacocat", "atcoeta", etc.)

2. Write an algorithm such that if an element in an MxN matrix is 0, its entire row and column are set to 0
3. A child is running up a staircase with n steps and can hop either 1 step, 2 steps, or 3 steps at a time. Implement a method to count how many possible ways the child can run up the stairs.
4. Write a method to compute all permutations of a string of unique characters.
5. In an array of integers, a "peak" is an element which is greater than or equal to the adjacent integers and a "valley" is an element which is less than or equal to the adjacent integers.
   For example, in the array {5, 8, 6, 2, 3, 4, 6}, {8, 6} are peaks and {5, 2} are valleys. Given an array of integers, sort the array into an alternating sequence of peaks and valleys.
   Example: Input: {5, 3, 1, 2, 3}
   Output: {5, 1, 3, 2, 3}
   (5 is a peak, 1 is a valley, 3 is a peak, 2 is a valley, etc)

Task Three: Mathematical Thinking.

Mathematical Thinking (or Critical Thinking) is a very important skill that any Developer is need in. Study these Problems and find their solutions in an efficient and reliable way.

1. You have 20 bottles of pills, where every bottle has a huge number of pills. 19 bottles have 1.0-gram pills, but one bottle has pills of weight of 1.5 grams. Given a scale that provides as exact measurement, how would you find the heavy bottle? You can only use the scale once.
2. There are three ants on different vertices of a triangle. What is the probability of collision (between any two or all of them) if they start walking on the sides of the triangle? Assume that each ant randomly picks a direction, with either direction being equally likely to be chosen, and they walk at the same speed.
   Similarly, find the probability of collision with n ants in an n-vertex polygon
3. You have There are 100 closed lockers in a hallway. A man begins by opening all 100 lockers. Next, he closes every second locker. Then, on his third pass, he toggles every third locker (closes it if it is open or opens it if it is closed). This process continues for 100 passes, such that on each pass i, the man toggles every ith locker. After his 100th pass in the hallway, in which he toggles only locker #100, how many lockers are open?