LAB WORKBOOK

21CS2214AA - DESGIN AND ANALYSIS OF ALGORITHM (DAA)
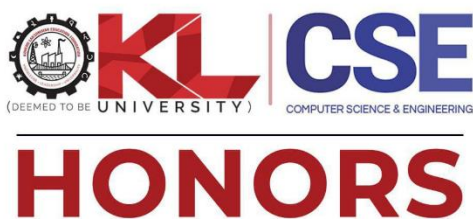
LABORATORY WORKBOOK

STUDENT NAME	
REG. NO	
YEAR	
SEMESTER	
SECTION	
FACULTY	

Table of contents

Organization of the STUDENT LAB WORKBOOK

The laboratory framework includes a creative element but shifts the time-intensive aspects outside of the Two-Hourclosed laboratory period. Within this structure, each laboratory includes three parts: Prelab, In-lab, and Post-lab.

a. Pre-Lab

The Prelab exercise is a homework assignment that links the lecture with the laboratory period - typically takes 2 hours to complete. The goal is to synthesize the information they learn in lecture with material from their textbook to produce a working piece of software. Prelab Students attending a two-hour closed laboratory are expected to make a good-faith effort to complete the Prelab exercise before coming to the lab. Their work need not be perfect, but their effort must be real (roughly 80 percent correct).

b. In-Lab

The In-lab section takes place during the actual laboratory period. The First hour of the laboratory period can be used to resolve any problems the students might have experienced in completing the Prelab exercises. The intent is to give constructive feedback so that students leave the lab with working Prelab software - a significant accomplishment on their part. During the second hour, students complete the In-lab exercise to reinforce the concepts learned in the Prelab. Students leave the lab having received feedback on their Prelab and In-lab work.

c. Post-Lab

The last phase of each laboratory is a homework assignment that is done following the laboratory period. In the Post-lab, students analyze the efficiency or utility of a given system call. Each Post-lab exercise should take roughly 120 minutes to complete.

2022-23 ODD SEMESTER LAB CONTINUOUS EVALUATION

Sl No	Date	Experiment Name	Pre-Lab (15M)			In-Lab(30M)				Viva Voce (5M)	Total (50M)	Faculty Signature
			Logic (5M)	Implementation (5M)	Execution (5M)	LOGIC (10M)	EXECUTION (10M)	RESULT (5M)	ANALYSIS (5M)			
1												
2												
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9												
10												
11												
12												

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
COURSE CODE: 21CS2214AA
COURSE TITLE: DESIGN AND ANALYSIS OF ALGORITHMS

Lab 1:

Date of the Session: ___/___/___   **Time of the Session: _____to_____**

Pre-Lab Task:

1. Calculate the time complexity of the following:

```
int binarySearch(int a, int low, int high, int tar)
{
int mid;
if (low > high)
return (0);
mid = floor((low + high)/2)
if (a[mid] == tar)
            return (mid)
else
            if tar < a[mid]
                  return binarySearch(a, low, mid-1, tar)
            else
                  return binarySearch(a, mid+1, high, tar)
  }
```

2. function fn(n)
    {
    if(n<0) return 0;
    if(n<2) return n;
    return fn(n-1)+fn(n-2);
    }

3) The median of a list of numbers is essentially its middle element after sorting. The same number of elements occur after it as before. Given a list of numbers with an odd number of elements, find the median?

Example

arr=[5,3,1,2,4]

The sorted array a'=[1,2,3,4,5]. The middle element and the median is 3.

Function Description

Complete the *findMedian* function in the editor below.

findMedian has the following parameter(s):

- *int arr[n]:* an unsorted array of integers

Returns

- *int:* the median of the array

Sample Input 0

```
7
0 1 2 4 6 5 3
```
Sample Output 0

3

In-Lab Task:

1) Given an array of strings **arr[]**, the task is to sort the array of strings according to frequency of each string, in ascending order. If two elements have same frequency, then they are to be sorted in alphabetical order.

Input: arr[] = {"Ramesh", "Mahesh", "Mahesh", "Ramesh"}

Output: ("Mahesh","Ramesh"}

Explanation:
As both the strings have same frequency, the array is sorted in the alphabetical order.

2) Given an array of strings **words[]** and the **sequential order** of alphabets, our task is to sort the array according to the order given. Assume that the dictionary and the words only contain lowercase alphabets.

Input: words = {"word", "world", "row"}, order = "worldabcefghijkmnpqstuvxyz"

Output: "world","word","row"

Explanation:
According to the given order 'l' occurs before 'd' hence the words "world" will be kept first.

Post-Lab Task:

1) Given an array arr[] of N strings, the task is to sort these strings according to the number of upper-case letters in them try to use zip function to get the format.

   Input arr[] = {poiNtEr, aRRAy, cOde, foR}

   Output: [('cOde', 1), ('foR', 1), ('poiNtEr', 2), ('aRRAy', 3)]

   "aRRAy" R, R, A->3 Upper Case Letters

   "poiNtEr" N, E->2 Upper Case Letters

   "cOde" O->2 Upper Case Letters

   "foR" R->3 Upper Case Letters

2) In KLU streets we have lots of electrical poles.
   Note: all poles are sorted with respective to their heights.

Professor Hari Vege given the H = height of one pole to Mothi then asked him to print the position of that pole, here we consider index as a position. Mothi is particularly good at algorithms, so he written an algorithm to find that position. But he is extremely poor at finding time complexity. Your task is to help your friend Mothi to analyze the time complexity of the given problem.

```
Int BinarySearch (int a, int low, int high, int tar)
 {
     int mid;
     if (low > high) return 0;
     mid = floor((low + high)/2)
     if (a[mid] == tar)
             return mid;
     else if (tar < a[mid])

             return BinarySearch (a, low, mid-1, tar)

     else
             return BinarySearch (a, mid+1, high, tar)
 }
```

(For Evaluator's use only)

Comment of the Evaluator (if Any)	Evaluator's Observation
	Marks Secured: _____ out of _____
	Full Name of the Evaluator:
	Signature of the Evaluator Date of Evaluation:

Lab 2:

Date of the Session: ___/___/___   **Time of the Session: _____to_____**

Pre-Lab:

1) Given a text txt[0..n-1] and a pattern pat[0..m-1], write a function search (char pat [], char

   txt[]) that prints all occurrences of pat[] in txt[] using naïve string algorithm?(assume that n > m)

   Input

   txt[] = "THIS IS A TEST TEXT"

   pat[] = "TEST"

   Output

   Pattern found at index 10

   Input

   txt[] = "AABAACAADAABAABA"

   pat[] = "AABA"

   Output

   Pattern found at index 0

   Pattern found at index 9

2) Discuss the Rabin Karp algorithm for string matching and explain time complexity of the algorithm?

3) Stefan is a guy who is suffering with OCD. He always like to align things in an order. He got a lot of strings for his birthday party as gifts. He like to sort the strings in a unique way. He wants his strings to be sorted based on the count of characters that are present in the string.

Input

aaabbc

cbbaaa

Output

aabbcc

aabbcc

If in case when there are two characters is same, then the lexicographically smaller one will be printed first

Input:

aabbccdd

aabcc

Output:
aabbccdd
baacc

In-Lab:

1) Naive method and KMP are two string comparison methods. Write a program for Naïve method and KMP to check whether a pattern is present in a string or not. Using clock function find execution time for both and compare the time complexities of both the programs (for larger inputs) and discuss which one is more efficient and why?

Sample program with function which calculate execution time:

```
#include<stdio.h>
#include<time.h>
void fun()
{
        //some statements here
}
int main()
{
        //calculate time taken by fun()
clock_t t;
        t=clock();
fun();
        t=clock()-t;
        double time_taken=((double)t)/CLOCK_PER_SEC; //in seconds
printf("fun() took %f seconds to execute \n",time_taken);
return 0;
}
```

2) Andrea is working in a photo studio where his boss has given him a task to arrange the photos of family members. He is French and he do not know English somehow, he managed to send the list of names to you (his friend). Help Andrea to sort the photos.
(Note: implement the odd even merge algorithm)

Input

5

Neil   Katherine   Harry   Stefan   Dennis

Output

Dennis   Harry   Katherine   Neil   Stefan

Post-Lab:

1) Given a pattern of length- 5 window, find the valid match in the given text by step-by-step process using Robin-Karp algorithm

Pattern: 2 1 9 3 6

Modulus: 21

Index: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

Text: 9 2 7 2 1 8 3 0 5 7 1 2 1 2 1 9 3 6 2 3 9 7

2) James is sharing his information with his friend secretly in a chat. But he thinks that message should not understandable to anyone only for him and his friend. So he sent the message in the following format.

Input
a1b2c3d4e

Output
abbdcfdhe

Explanation:

The digits are replaced as follows:

- s[1] -> shift('a',1) = 'b'
- s[3] -> shift('b',2) = 'd'
- s[5] -> shift('c',3) = 'f'
- s[7] -> shift('d',4) = 'h'

(For Evaluator's use only)

Comment of the Evaluator (if Any)	Evaluator's Observation
	Marks Secured:_____out of_____
	Full Name of the Evaluator:
	Signature of the Evaluator Date of Evaluation:

Lab 3:

Date of the Session: ___/___/___   **Time of the Session: _____to_____**

<u>**Pre-Lab-Task:**</u>

1) Calculate the time complexity of the following:
    ```
    void multiply(int A[][N], int B[][N], int C[][N])
    {
        for (int i = 0; i < N; i++)
        {
            for (int j = 0; j < N; j++)
            {
                C[i][j] = 0;
                for (int k = 0; k < N; k++)
                {
                    C[i][j] += A[i][k]*B[k][j];
                }
            }
        }
    }
    ```

2) Given two arrays of integers, find which elements in the second array are missing from the first array.

Example:

A={7,2,5,3,5,3}

B={7, 2, 5, 4, 6, 3, 5, 3}

The 'B' array is the original list. The numbers missing are {4, 6}.

Sample Input

10
203 204 205 206 207 208 203 204 205 206
13
203 204 204 205 206 207 205 208 203 206 205 206 204
Sample Output

204 205 206

3) Trace out the output of the following using Merge sort. 19, 48, 32, 66, 45, 4, 7, 2, 1, 51, 78, 34, 89, 87, 36, 29, 3, 9, 11.

In-Lab Task:

1) You are given an array *A*. You can decrement any element of the array by *1*. This operation can be repeated any number of times. A number is said to be missing if it is the smallest positive number which is a multiple of *2* that is not present in the array *A*. You must find the maximum missing number after all possible decrements of the elements.

Input Format:
The first line of input contains *T* denoting number if test cases.
The first line of each test case contains *N*, the size of the array.
The second line of each test case contains *N* space seperated intergers.

Output Format:
Print the answer for each test case in a new line.

Sample Input:
2
6
1 3 3 3 6 7
3
3 0 2

Sample Output:
8
4

2) Watson gives Sherlock an array of integers. His challenge is to find an element of the array such that the sum of all elements to the left is equal to the sum of all elements to the right.

Example

A= [5, 6, 8, 11]

8 is between two subarrays that sum to 11.

A=[1]

The answer is [1] since left and right sum to 0.

You will be given arrays of integers and must determine whether there is an element that meets the criterion. If there is, return YES. Otherwise, return NO.

Sample Input 0

```
2
3
1 2 3
4
1 2 3 3
```
Sample Output 0

```
NO
YES
```

Post-Lab Task:

1) Given a list of N array elements apply Merge sort.

*Note: Merge Sort is a Divide and Conquer algorithm. It divides input array in two halves, calls itself for the two halves and then merges the two sorted halves.

Input Format

• The first line contains an integer, N, the number of elements in Array.

• The second line contains N space-separated integers.

Constraints

1<= N <= 1000

-1000 <= array elements <= 1000

Output Format

Print the array as a row of space-separated integers each iteration

Sample Input 0
```
10
10 1 9 2 8 3 4 7 5 6
```
Sample Output 0
```
1 10
1 9 10
2 8
1 2 8 9 10
3 4
3 4 7
5 6
3 4 5 6 7
1 2 3 4 5 6 7 8 9 10
```

2)

HackerLand National Bank has a simple policy for warning clients about possible fraudulent account activity. If the amount spent by a client on a particular day is *greater than or equal to 2X* the client's median spending for a trailing number of days, they send the client a notification about potential fraud. The bank doesn't send the client any notifications until they have at least that trailing number of prior days' transaction data.

Given the number of trailing days d and a client's total daily expenditures for a period of n days, determine the number of times the client will receive a notification over all n days.

Example

expenditure=[10,20,30,40,50]

d=3

On the first three days, they just collect spending data. At day 4, trailing expenditures are [10,20,30]. The median is 20 and the day's expenditure is 40. Because 40>=2X20, there will be a notice. The next day, trailing expenditures are [20, 30, 40] and the expenditures are 50. This is less than 2X30 so no notice will be sent. Over the period, there was one notice sent.

Note: The median of a list of numbers can be found by first sorting the numbers ascending. If there is an odd number of values, the middle one is picked. If there is an even number of values, the median is then defined to be the average of the two middle values.

Sample Input 0

STDIN   Function
-----   --------
9 5   expenditure[] size n =9, d = 5
2 3 4 2 3 6 8 4 5   expenditure = [2, 3, 4, 2, 3, 6, 8, 4, 5]

Sample Output 0

2

(For Evaluator's use only)

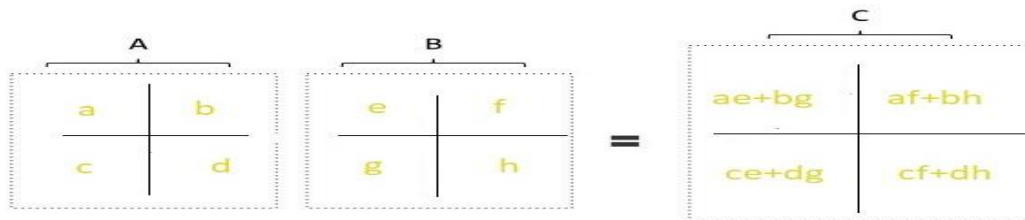| Comment of the Evaluator (if Any)	Evaluator's Observation
	Marks Secured: _____ out of _____ Full Name of the Evaluator: Signature of the Evaluator Date of Evaluation:

Lab 4:

Date of the Session: ___/___/___   **Time of the Session: _____to_____**

<u>**Pre-Lab Task:**</u>

1) Trace the output of the following matrix multiplication using Strassen's Multiplication Method


    A, B and C are the Matrices of Size NxN

    a, b, c and d are the sub-Matrices of A of size N/2xN/2

    e, f, g and h are the sub-Matrices of B of size N/2xN/2

2) Write a divide and conquer algorithm for finding the maximum and minimum in the sequence of numbers. Find the time complexity.

3) Given an input is an array of points specified by their x and y co-ordinates. The output is the convex hull of this set of points by using Divide and Conquer algorithm.
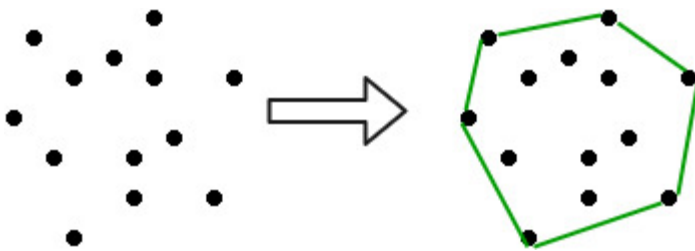
Input : points[] = {(0, 0), (0, 4), (-4, 0), (5, 0),

   (0, -6), (1, 0)};

Output : (-4, 0), (5, 0), (0, -6), (0, 4)

In-Lab:

1) Harry's Aunt and family treat him badly and make him work all the time. Dudley, his cousin got homework from school and he as usual handed it over to Harry but Harry has a lot of work and his own homework to do.

   The homework is to solve the problems which are numbered in numerical he tries to solve random question after solving random questions he did not put those questions in order Dudley will return in a time of n*logn Harry has to arrange them as soon as possible. Help Harry to solve this problem so that he can go on and do his own homework.

   Example
   Input

   9

   15,5,24,8,1,3,16,10,20

   Output

   1, 3, 5, 8, 10, 15, 16, 20, 24

2) A group of 9 friends are playing a game, rules of the game are as follows: Each member will be assigned with a number and the sequence goes like e.g.: 7,6,10,5,9,2,1,15,7.
Now they will be sorted in ascending order in such a way that tallest one will be sorted first. Now your task is to find the order of indices based on initial position of the given sequence and print the order of indices at the end of the iteration.

Post-Lab:

1) Suppose a merge sort algorithm, for input size 64, takes 30 secs in the worst case. What is the maximum input size that can be calculated in 6 minutes (approximately)?

2) Chris and Scarlett were playing a block sorting game where Scarlett challenged Chris that he has to sort the blocks which arranged in random order. And Scarlett puts a restriction that he should not use reference of first, median and last blocks to sort, and after sorting one block with reference to other block, for next iteration he must choose another block as the reference not the same block (random pivot).

Now, Chris wants help from you to sort the blocks. He wanted to sort them in a least time. Help him with the least time complexity sorting algorithm.

Input format

First line of input contains the number of test cases.

Next t lines of input contain

The number of blocks provided by Scarlett.

The array of blocks.

(For Evaluator's use only)

Comment of the Evaluator (if Any)	Evaluator's Observation
	Marks Secured:_____out of_____
	Full Name of the Evaluator:
	Signature of the Evaluator Date of Evaluation:

Lab 5:

Date of the Session: ___/___/___   **Time of the Session: _____to_____**

Pre-Lab Task:

1. Given N integers a1,a2,...aN, generate all N- dimentional points (x1,x2,...xN) such thatxi is an integer and 0<=xi<=ai (i=1,2...N). Your task is to find the number of ways to select two points A and B from this set, such that the midpoint of A and B also lies in this set. A and B can be same also.

    Input Format:
    First line of input contains a single integer N. The second line contains N integers, the ith of them representing ai, as defined in the problem.

    Output Format:
    The output contains a single integer, the answer to the problem

    Sample input:

    2

    1 2

    Sample Output:

    10

2. Given an array of integers A and a positive integer k, find whether it's possible to divide this array into sets of k consecutive numbers
Return True if its possible otherwise return False.

Example 1:
Input: A = [1,2,3,3,4,4,5,6], k = 4
Output: true
Explanation: Array can be divided into [1,2,3,4] and [3,4,5,6].
Example 2:
Input: A = [3,2,1,2,3,4,3,4,5,9,10,11], k = 3
Output: true
Explanation: Array can be divided into
 [1,2,3] , [2,3,4] , [3,4,5] and [9,10,11].
Example 3:
Input: A = [3,3,2,2,1,1], k = 3
Output: true
Example 4:
Input: A = [1,2,3,4], k = 3
Output: false
Explanation: Each array should be divided in subarrays of size 3.

In-Lab Task:

3. A team of people would like to buy a bouquet of roses. The vendor wants to maximize his wide variety of recent clients count and the cash he makes. To do so, he decides to multiply the price of each rose with the aid of the wide variety of that clients previously purchased roses plus 1. The first rose will be original price,(0+1) x original price , the next will be (1+1) x original price and so on.

    Given the size of the group of people, the number of roses they want to purchase and the original prices of the rose, determine the minimum cost to purchase all of the roses.

    For example, if there are k=3 group of people such that want to buy n=4 roses that cost c=[1,2,3,4] each will buy one of the roses priced [2,3,4] at the original price. Having each purchased x=1 rose, the first rose in the list,c[0] , will now cost (cuurent purchase + previous purchases) x c[0] = (1 + 1) x 1 = 2. The total cost will be $2 + 3 + 4 + 2 = 11$.

    Input Format

    The first line contains two space-separated integers n and k, the number of roses and group of people.
    The second line contains n space-separated positive integers c[i], the original price of each rose.

    Ouput Format

    Print the minimum cost to buy all nroses.

    Sample Input 0
    3 3
    2 5 6
    Sample Output 0
    13
    Explanation 0
    There are n=3 rosess with costs c = [2,5,6] and k=3 people in the team. If each person buys one rose, the total cost of prices paid is $2 + 5 + 6 = 13$ dollars. Thus, we print 13 as our answer.

    Sample Input 1
    3 2
    2 5 6
    Sample Output 1
    15
    Explanation 1

    There are n=3 flowers with costs c=[2,5,6] and k=2 people in the team. We can minimize the total purchase cost like so:

The first person purchases 2 roses in order of decreasing price; this means they buy the more expensive rose (c1=5) first at price p1= (0 + 1) x 5 = 5 dollars and the less expensive flower (c0=2) second at price p0= (1 + 1) x 2 = 4 dollars.

The second person buys the most expensive rose at price p2 = (0 + 1) x 6 = 6 dollars.

We then print the sum of these purchases, which is 5 + 4 + 6 = 15 , as our answer.

Sample Input 2
5 3
1 3 5 7 9
Sample Output 2
29
Explanation 2
The friends buy flowers for 9, 7 and 3,5 and 1 for a cost of 9 + 7 + 5 + (1 + 1) * 3 + (1 + 1) * 1 = 29.

4. Given a non-negative integer N, find the largest number that is less than or equal to N with monotonically increasing digits.
(Recall that an integer has monotonically increasing digits if and only if each pair of adjacent digits x and y satisfy x <= y.)
Example 1:
Input: N = 10
Output: 9
Example 2:
Input: N = 1234
Output: 1234
Example 3:
Input: N = 332
Output: 299

Post-Lab Task:

5. There are n people whose IDs go from 0 to n - 1 and each person belongs exactly to one group. Given the array groupSizes of length n telling the group size each person belongs to, return the groups there are and the people's IDs each group includes.

   You can return any solution in any order and the same applies for IDs. Also, it is guaranteed that there exists at least one solution.

   Example 1:
   Input: groupSizes = [3,3,3,3,3,1,3]
   Output: [[5],[0,1,2],[3,4,6]]
   Explanation: Other possible solutions are [[2,1,6],[5],[0,4,3]] and [[5],[0,6,2],[4,3,1]].
   Example 2:
   Input: groupSizes = [2,1,3,3,3,2]
   Output: [[1],[0,5],[2,3,4]]

6. Tom is a teacher in nursery school. She wants the kids in her class to get some sweets. All the kids sit in a line and each of them has a ranking score in the class according to their results. Tom wants to give every kid a minimum of 1 sweet. When two kids are sitting next to each other, then the one with the better rating gets more sweets. Tom wants the total number of sweets to be minimised.and every of them has a score score in step with his or her performance inside the class.

Input Format
The first line contains an integer, n, the size of array .
Each of the next n lines contains an integer a[i] indicating the rating of the kid at position i.

Output Format
Output a single line containing the minimum number of candies Alice must buy.

Sample Input 0
3
1
2
2

Sample Output 0
4

Explanation 0
Here 1, 2, 2 is the rating. Note that when two kids have equal rating, they are allowed to have different number of sweets. Hence optimal distribution will be 1, 2, 1.

Sample Input 1
10
2
4
2
6
1
7
8
9
2
1

Sample Output 1
19

Explanation 1
Optimal distribution will be 1, 2, 1, 2, 1, 2, 3, 4, 2, 1.

Sample Input 2

8
2
4
3
5
2
6
4
5

Sample Output 2
12

Explanation 2
Optimal distribution will be 1, 2, 1, 2, 1, 2, 1, 2.

(For Evaluator's use only)

Comment of the Evaluator (if Any)	Evaluator's Observation
	Marks Secured: _____ out of _____ Full Name of the Evaluator: Signature of the Evaluator Date of Evaluation:

Lab 6:

Date of the Session: ___/___/___   **Time of the Session: _____to_____**

<u>**Pre-Lab:**</u>

1) Explain why 0-1 Knapsack problems cannot be solved using greedy method unlike fractional knapsack.

2) Categorize the Following as single source or multiple source shortest path algorithms.

Floyd-Warshall algorithm

Dijkstra's algorithm –

Bellman-Ford algorithm –

3) List down various shortest path greedy algorithms.

In-Lab:

1) Given an array of size n that has the following specifications:
   a. Each element in the array contains either a police officer or a thief.

   b. Each police officer can catch only one thief.
   c. A police officer cannot catch a thief who is more than K units away from the police officer.

We need to find the maximum number of thieves that can be caught.

Input
arr [] = {'P', 'T', 'T', 'P', 'T'},
k = 1.
Output
 2
Here maximum 2 thieves can be caught; first police officer catches first thief and second police officer can catch either second or third thief.

2) Given n non-negative integers a1, a2, ..., an, where each represents a point at coordinate (i, ai). n vertical lines are drawn such that the two endpoints of the line i is at (i, ai) and (i, 0). Find two lines, which, together with the x-axis forms a container, such that the container contains the most water. Notice that you may not slant the container.

Input

 height = [1,8,6,2,5,4,8,3,7]

Output

 49

Explanation: The above vertical lines are represented by array [1,8,6,2,5,4,8,3,7]. In this case, the max area of water (blue section) the container

Post-Lab:

1) Given an array of jobs where every job has a deadline and associated profit if the job is finished before the deadline. It is also given that every job takes a single unit of time, so the minimum possible deadline for any job is 1. How to maximize total profit if only one job can be scheduled at a time.

Input

4

Job ID Deadline Profit

a   4   20

b   1   10

c   1   40

d   1   30

Output

60

profit sequence of jobs is c, a

2) There are N Mice and N holes are placed in a straight line. Each hole can accommodate only 1 mouse. A mouse can stay at his position, move one step right from x to x + 1, or move one step left from x to x − 1. Any of these moves consumes 1 minute. Assign mice to holes so that the time when the last mouse gets inside a hole is minimized.

Example: positions of mice are: 4 -4 2

Positions of holes are: 4 0 5

Input:

A: list of positions of mice

B: list of positions of holes

Output:

single integer value

(For Evaluator's use only)

Comment of the Evaluator (if Any)	Evaluator's Observation
	Marks Secured:_____out of_____
	Full Name of the Evaluator:
	Signature of the Evaluator Date of Evaluation:

LAB SESSION 07:

Date of the Session:___/___/____   **Time of the Session:_____to_____**

<u>**Pre-Lab:**</u>

1) A student named Satish is eagerly waiting to attend tomorrow's class. As he searched the concepts of tomorrow's lecture in the course handout and started solving the problems, in the middle he was stroked in the concept of strings because he was poor in this concept so help him so solve the problem, given two strings str1 and str2 and below operations that can performed on str1. Find minimum number of edits (operations) required to convert 'str1' into 'str2'.

   1. Insert
   2. Remove
   3. Replace

   Input
   str1 = "cat", str2 = "cut"
   Output
   1
   We can convert str1 into str2 by replacing 'a' with 'u'.
   Input
   str1 = "sunday", str2 = "saturday"
   Output
   3

2) Given N numbers n1,n2,…nN and Q queries q1,q2,…qQ. Your task is to print Q (Q< j <numbers) f1,f2,…fQ, corresponding to query qj1 max(n1=fj ,n2 ,...nq) using dynamic programming.

Input
5 3
5 4 8 6 9
 2 3 5

Output
5 8 9

In-Lab:

1) Bhanu is a student at KL University who likes playing with strings, after reading a question from their lab workbook for the ADA Course she found what is meant by a subsequence.

(A subsequence is a sequence that can be derived from another sequence by deleting some or no elements without changing the order of the remaining elements)

So, she created 2 strings out of which one she considered as a master string and the other one as a slave string. She challenged her friend Teju to find out whether the slave string is a subsequence of the master string or not, As Teju is undergoing her CRT classes she decided to code the logic for this question. Help her in building the logic and write a code using Dynamic programming concept.

2) Geeta is working in a company, and she has n different projects to work on, where every project is scheduled to be done from startTime[i] to endTime[i], obtaining a profit of profit[i]. You are given the startTime, endTime and profit arrays, return the maximum profit you can take such that there are no two projects that she is working on in that given subset with overlapping time range. If she chooses a project that ends at time a then she will be able to start another project that starts at time b.

Input
startTime = [1,2,3,4,6], endTime = [3,5,10,6,9], profit = [20,20,100,70,60]
Output
150
Explanation: The subset chosen is the first, fourth and fifth project.
Profit obtained 150 = 20 + 70 + 60.

3) Teacher: good morning students!!!

Students: good morning mam

Teacher: Today topic is binary tree. Does anyone know what is binary tree?

Students: no mam

Teacher: In computer science, a binary tree is a tree data structure in which each node has at most two children, which are referred to as the left child and the right child. Satish you completed this topic yesterday can you explain this topic?

Satish: Sure, mam but I got doubt this concept, do anyone help me in solving this the question was Given a binary tree, find whether if a given Binary Tree is Balanced?
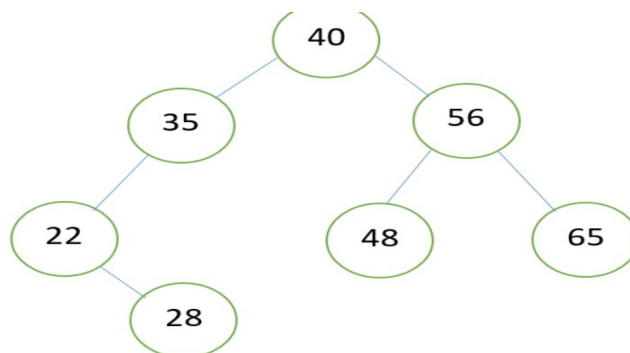
<u>**Post-Lab:**</u>

1) SIRI studies at KL University and a person who is interested in Dynamic Programming, she created a question for you to solve. she decided to give a question related to palindrome, you need to use dynamic programming to solve this problem brute force is not allowed since she hates waiting too long to find the answer. The question follows like this find the longest palindromic subsequence.

   (Unlike substrings, subsequences are not required to occupy consecutive positions within the original string.)
   Input
   ABBDCACB
   Output
   The length of the longest palindromic subsequence is 5
   The longest palindromic subsequence is BCACB

2) Bhanu and Teju are playing dice game where there are N dice with M faces and the dice are numbered from 1 to M. A person wins the game if the sum of the faces of dice adds up to a value X. you are playing on Bhanu's team, and It is Teju's turn now.

You are supposed to find number of ways your opponent can win the game where N, M and X are provided as input. Use Dynamic programming to solve the problem.

Using DP (Dynamic programming) to find the number of ways to get sum X.

Input
M = 2
N = 2
X = 3
Output
2

# LAB SESSION 08:

Pre-Lab:

1) Your father brought you a ticket to world tour. You have a choice to go to three places, your father knows the places you wanted to travel so he made a graph with the measuring distances from home. Now you start from your place (1: Source) to other places as shown in the graph below apply TSP to find shortest path to visit all places and return to home. (Ex: 2: London, 3: Paris, 4: Singapore)
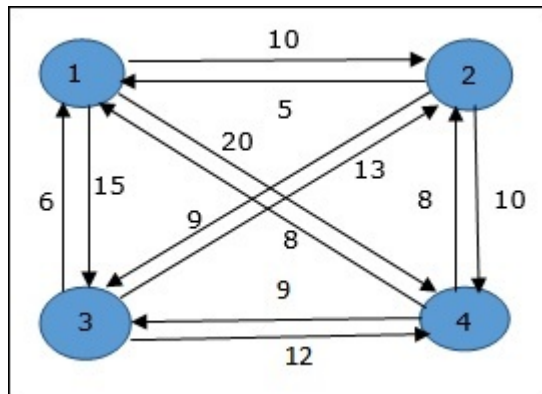
2) You are given a map(graph) with the distances between the places. Here you will consider the 1st node as the starting point and ending point, Since the route is cyclic you can take any node as starting point and ending point. Find the minimum cost route and remember the Hamiltonian cycle.
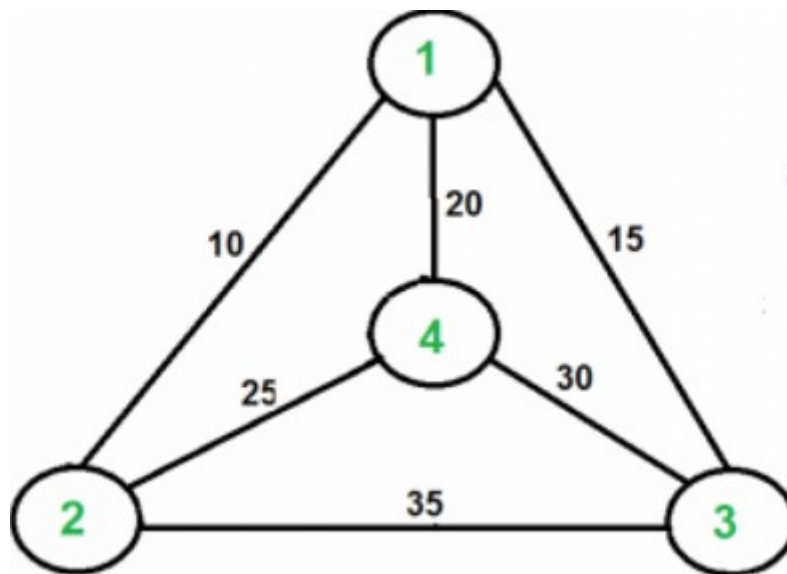
3) Your friend works in a comparable way to a Travelling salesperson — he always travels to new cities to sell his delicious dishes.

Today, your friend is planning to visit N cities (numbered 1 through N). There is a direct way to travel between each pair of cities. Each city has a specific temperature; let us denote the temperature in the i-th city by C_i. Your friend has a fixed temperature tolerance D with the following meaning: for each pair of cities an and b, he may travel from city a directly to city b only if $|C_a - C_b| \le D$, otherwise he would catch a heavy flu because of the sudden change in temperature.

Your friend starts from city 1. Is he able to visit all N cities in such a way that each city is visited exactly once?

Notes:
1. Your friend is not able to travel through a city without visiting it.
2. City 1 is visited at the beginning.

It is not necessary to be able to travel directly to city 1 from the last city Your friend's visits.

Input
2
5 3
3 2 1 4 5
5 4
10 1 3 2 9

Output
Yes
No

In-Lab:

1) Emma has a graph which represents a flow network where every edge has a capacity. Also given two vertices source s and sink t in the graph, fin the maximum possible flow from s to t with following constraints:
   a.   Flow on an edge does not exceed the given capacity of the edge.
   b.   Incoming flow is equal to outgoing flow for every vertex except s and t.
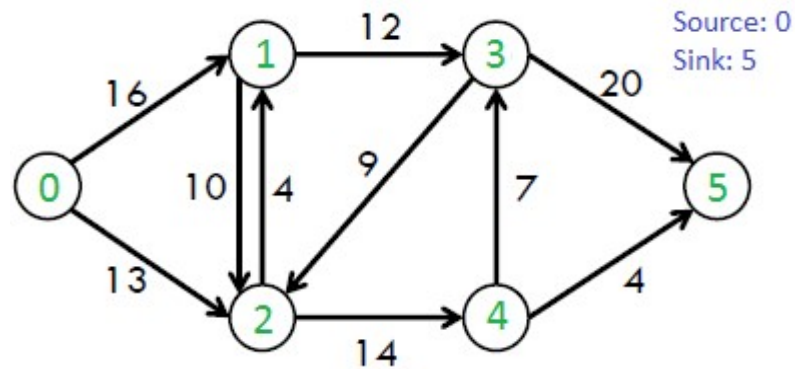
Find the Maximum flow using the graph and by implementing the code.

2) For the above given graph Emma wants an s-t to cut that requires the source s and the sink t to be in different subsets, and it consists of edges going from the source's side to the sink's side. So, she wants you to find the minimum capacity s-t cut of the given network. Expected output is all the edges of minimum cut.

Post-Lab:

1) Hogwarts has yet again declared The Triwizard tournament. Harry must pass this round to get to the next one. Each participant will be given a graph with vertices as shown below. Each vertex is a dungeon, and a golden egg is placed in the root dungeon i.e., the root vertex. Help harry find the dungeon with the golden egg using traversing or searching tree or graph data structure. (P.S: To pass this round Harry must write a code).

2) KL University is starting next week. There are S subjects in total, and you need to choose K of them to attend each day, you required number of credits to pass the semester. There are N+1 buildings. Your hostel is in building number 0. Subject j is taught in building Bj. After each subject, you have a break, during which you go back to your hostel. There are M bidirectional paths of length 1 which connects building b1 to building b2. Find the minimum total distance you need to travel each day if you choose your subjects correctly.

Input

2 3 2 2

0 1

1 2

2 0

1 2

Output

4

LAB SESSION 09:

Date of the Session:___/___/____   **Time of the Session:**_____to_____

<u>**Pre-Lab:**</u>

1) What is Back Tracking methodology and when can we use Back tracking, explain with an example?

2) Mr. Anumula went to the Ice-Cream Parlor. He will be with certain amount of money to buy ice-creams. When he goes to the counter for ordering the Ice-cream, there will be displayed with the items and its cost, respectively. He will be checking which items he can buy according to the money. Print "YES" if he can buy the Ice-Creams without leaving one rupee also otherwise print "NO".

Input
costs= [100, 70, 50, 180, 120, 200, 150]
Total Money=300
Output
 YES

1) Mani is poor at playing chess, he was asked to arrange "N" Queens on the chess board in such a way that no two queens are allowed to kill each other. Since he is poor at chess you were asked to arrange them on behalf of him. (You must use Backtracking Approach)

2) Given an undirected graph and N colors, the problem is to find if it is possible to color the graph with at most N colors, which means assigning colors to the vertices of the graph such that no two adjacent vertices of the graph are colored with the same color.

Print "Possible" if it is possible to color the graph as mentioned above, else print "Not Possible".

Input
1
3 2
0 2
1 2
2
Output
Possible

Post-Lab:

1) Kiran is a very obedient boy and helping others is a habit of him. He will do any work with dedication his teacher assigns him a work to generate all permutations of given word. Since he is busy helping others, you are asked to help him to complete his work on behalf of him. (Use Backtracking Concept)

2) Mr. Sai joined for as an assistant at a school where he was given a job to arrange schedules for the subject n1, n2, n3, n4, n5, n6, n7, n8. Help him schedule the timetable from the given information.

Let this be the schedule:
Here for everyone hour there are many subjects competing. Use backtracking and create a schedule where each subject is assigned to a specific hour in a day. In the schedule '1' represents that the subject is competing for that hour.

| Hours	Subjects	N1	N2	N3	N4	N5	N6	N7	N8
	1	0	1	0	1	1	1	0	1
	2	1	0	0	0	1	1	0	0
	3	0	0	0	0	0	1	1	1
	4	1	0	0	0	0	0	0	1
	5	1	1	0	0	0	1	0	0
	6	1	1	1	0	1	0	1	0
	7	0	0	1	0	0	1	0	0
	8	1	0	1	1	0	0	0	0

LAB SESSION 10:

Date of the Session:___/___/____   **Time of the Session:_____to_____**

Pre-Lab:

1)Given a set of cities and distance between every pair of cities, the problem is to find the shortest possible route that visits every city exactly once and returns to the starting point. Note the difference between Hamiltonian Cycle and TSP. The Hamiltonian cycle problem is to find if there exist a tour that visits every city exactly once. Here we know that Hamiltonian Tour exists (because the graph is complete) and in fact many such tours exist, the problem is to find a minimum weight Hamiltonian Cycle.
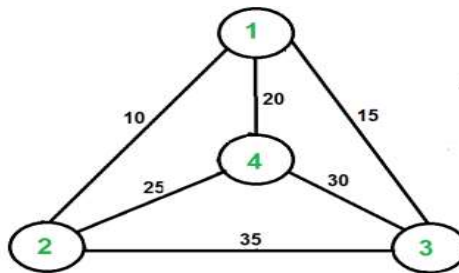
For example, consider the graph shown in figure on right side. A TSP tour in the graph is 1-2-4-3-1. The cost of the tour is 10+25+30+15 which is 80.
The problem is a famous NP hard problem. There is no polynomial time know solution for this problem. Find the different solutions for the traveling salesman problem.

In-Lab:

1) From Our Galaxy nearly 10^9+7 trillion kilometers far away, there exists a parallel Universe of Light called the Smolen of cosmos where each planet is called a Temp. There are total N temps. Unlike humans, the extraterrestrial can travel from one temp to another through Cosmic Bridges and the distance observed by them between any two temps is 0 units

   But the year 2012, proved to be a curse for extraterrestrial. This year, a Mega Star Urus struck their Universe and damaged many Cosmic Bridges. However, the God of Light ensured that for any two distinct temps t1 and t2 there exists exactly one unique path through Cosmic Bridges, but the distance between two directly connected temps through a Bridge has now increased to 1 unit.
   To prevail the existence of this Universe, the God of Light carved himself into exactly N extraterrestrial which now rule the N temps and are independent of each other. One by one, the ith extraterrestrial (0≤i≤N−1) transmits Light pulses through the network of Cosmic Bridges and determines the sum of distances to the remaining N−1 extraterrestrial.
   Can you help them find these quantities so they can reunite into God of Light again?

   Input
   5
   0 2
   0 3
   1 3
   3 4
   Output
   6 8 9 5 8

2) 2 years ahead, you planned a road trip as a reunion with all your classmates. You planned to visit N places in total, the list of their coordinates (arr []) are given in sorted order. You start the tour from the left most location and strictly move towards the right and then upon reaching the right most location, the tour goes strictly from right to left-back to the starting location. Find the minimum distance of the tour so that you can save time and fuel.

Input
N = 7
arr[][] = {{0, 6}, {1 0}, {2 3}, {5 4}, {6 1}, {7 5}, {8 2}}
Output
 25.582

Post-Lab:

1) Jane has very less Marks in Dynamic programming test conducted by his teacher. So, the teacher had given a problem about optimal Binary Search Tree which should be solved using Dynamic Programming by the next class. Since, he is very weak in Dynamic programming you must help him to solve the problem. The problem can be described as follows: An unsorted data of keys and their frequencies are given to you and some queries where each query contains two integers which describe the Range of the indices (index range) for which you must print the root of that Optimal Binary Search Tree. Tasks: (i)You should Find the Cost of the optimal BST (Binary Search Tree)by considering all the keys and print the value in a new Line. (ii)Find and print the root of the Optimal BST formed by the range of indices (keys index range) given by each sub-query. The first line contains integer 'n' which describes the size of the keys. The second line contains values of keys. The third Line contains values about frequencies of each key. The fourth Line is an integer 'm' which describes no of queries. The following lines contains two integers describing the range for each query. Print the cost of the Optimal BST by considering all the keys. For each Query print the root of the Optimal BST based on the given range

Input
4
12 10 20 21
2
03
01
Output
Cost of Optimal BST is 144
20
10

2) You are offered N pay packages by various companies, Congratulations! You can only select 2 unique groups of packages each with a total of at least K. Select the 2 groups such that you choose minimum number of companies adding up to the total of K.

Input
arr[] = {2, 4, 5, 6, 7, 8}, K = 16
Output
6
Explanation:
The subsets {2, 6, 8} and {4, 5, 7} are the two smallest subsets with sum K (= 16).
Therefore, the sum of the lengths of both these subsets = 3 + 3 = 6.4

LAB SESSION 11:

Date of the Session:___/___/____   **Time of the Session:_____to_____**

Pre-Lab:

1) Match the data structure used to generate branch and bound strategy.

Queue Data Structure	LIFO Branch and Bound Strategy
Stack Data Structure	Best First branch and bound strategy
Priority Queue	FIFO Branch and Bound Strategy

2) You are given a knapsack that can carry a maximum weight of 60. There are 4 items with weights {20, 30, 40, 70} and values {70, 80, 90, 200}. What is the maximum value of the items you can carry using the knapsack?

1) A Professor is teaching about Binary Numbers. He wants to know all the possible binary numbers of a given length. Help the Professor to generate all the set of binary strings of length N in ascending order using Branch and Bound Technique.

   Input
   N = 3
   Output
   000
   001
   010
   011
   100
   101
   110
   111
   Explanation:
   Numbers with 3 binary digits are
   0, 1, 2, 3, 4, 5, 6, 7

2) You are in a supermarket shopping for fruits with huge discounts. There are N varieties of fruits available each with a weight C and discount P. Now, select K fruits in a way that maximizes the discount. You only have a bag which can carry a weight of W.

Input
N = 5
P [] = {2, 7, 1, 5, 3}C [] = {2, 5, 2, 3, 4}, W = 8, K = 2.
Output
12
Explanation:
Here, the maximum possible profit is when we take 2 items: item2 (P[1] = 7 and C[1] = 5) and item4 (P[3] = 5 and C[3] = 3).
Hence, maximum profit = 7 + 5 = 12

Post-Lab:

1) Given an array of positive elements, you must flip the sign of some of its elements such that the resultant sum of the elements of array should be minimum non-negative (as close to zero as possible). Return the minimum no. of elements whose sign needs to be flipped such that the resultant sum is minimum non-negative. Note that the sum of all the array elements will not exceed 104.

   Input
   arr [] = {15, 10, 6}
   Output
   1
   Here, we will flip the sign of 15
   and the resultant sum will be 1.

2) There are some processes that need to be executed. The amount of load that process causes a server that runs it, is being represented by a single integer. The total load caused on a server is the sum of the loads of all the processes that run on that server. You have at your disposal two servers, on which the mentioned processes can be run. Your goal is to distribute given processes between those two servers in a way that, the absolute difference of their loads will be minimized.

Given an array of A[] of N integers, which represents loads caused by successive processes, the task is to print the minimum absolute difference of server loads.

Input
A[] = {1, 2, 3, 4, 5}
Output
1
Explanation:
Distribute the processes with loads {1, 2, 4} on the first server and {3, 5} on the second server, so that their total loads will be 7 and 8, respectively.
The difference of their loads will be equal to 1.

LAB SESSION 12:

Date of the Session:___/___/____   **Time of the Session:_____to_____**

Pre-Lab:

1) Read the following conversation

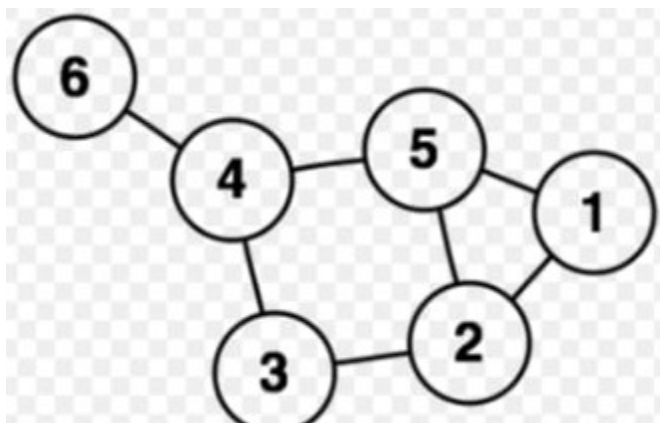   Jaya: Travelling salesman problem is a NP hard problem.

    Hema: I do not think so

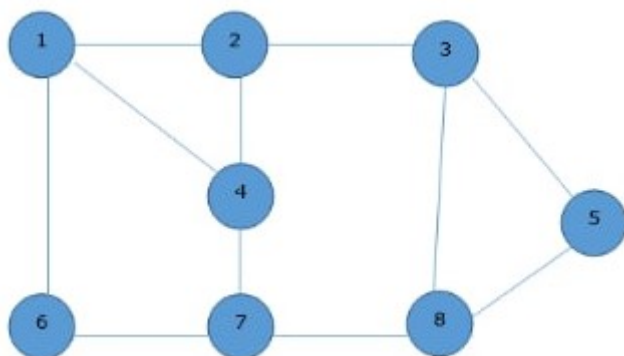   Jaya: No, I am so sure that Travelling Salesman problem is a NP hard problem.

    Hema: …!!

    You are Jaya's friend. Help her prove her statement.

2) Consider the two graphs and find out the node cover for the each of the graphs and specify the maximum node cover.

a)

b)

1) Raju prepares for the examination, but he got stuck into a concept called "NP-HARD AND "NP-COMPLETE PROBLEMS" on Nondeterministic Algorithms. So, help Raju to score good marks. Help him to define the Nondeterministic algorithms by sorting an array.

2) Karthik and Bavya are trying to implement a program that helps a transportation company use its container to maximum efficiency, as part of their CS project.

Few objects are more valuable than others. Each object has a certain weight. The transportation company wants to fill the container so that the value of the container (sum of value of objects in the container) is maximum, while total weight of the objects does not exceed the container's capacity.

As the outcome is not fixed, this is a non-deterministic problem. This is a knapsack problem as we must maximize value within the given weight limit.

So, to understand the problem well and implement it, help them in finding non-deterministic knapsack algorithm.
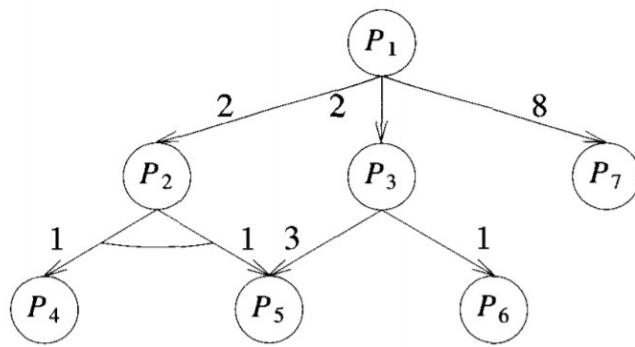
Post-Lab:
1) Hema: Hamiltonian Path is NP-Complete.
   Jaya: Well, prove that!
   Hema: I will prove and let you know.
   Help Hema to try and prove that Hamilton Path is NP-Complete

2) Hemanth was unable to answer the following question in exam. Here is the question, help Hemanth to find P1 solution. Find the total cost to find the P1 solution

LAB SESSION 13:

Date of the Session:___/___/____   **Time of the Session:_____to_____**

1)Given an array of integers A and a positive integer k, find whether it is possible to divide this array into sets of k consecutive numbers. Return True if it is possible otherwise return False.

Input:

A = [1,2,3,3,4,4,5,6], k = 4

Output

True

Explanation: Array can be divided into [1,2,3,4] and [3,4,5,6].

Input

A = [3,2,1,2,3,4,3,4,5,9,10,11], k = 3

Output

True

Explanation: Array can be divided into [1,2,3], [2,3,4], [3,4,5] and [9,10,11].

Input

A = [3,3,2,2,1,1], k = 3

Output

True

Input

A = [1,2,3,4], k = 3

Output

False

Explanation: Each array should be divided in subarrays of size 3.

2) Given a string Str of characters from 1 to 9. Your task is print a string Str1 of numbers using dynamic programming such that

a. |Str1|=|Str|

b. The ith character of Str1 is the number of even characters from ith position to last position of Str.

Input
475854637834259

Output
766655433322100

In-Lab:

1) Raju has very less Marks in Dynamic programming test conducted by his teacher. So, the teacher had given a problem about optimal Binary Search Tree which should be solved using Dynamic Programming by the next class. Since, he is very weak in Dynamic programming you must help him to solve the problem. The problem can be described as follows:

An unsorted data of keys and their frequencies are given to you and some queries where each query contains two integers which describe the range of the indices (index range) for which you must print the root of that Optimal Binary Search Tree.

Input
4
12 10 20 21
8 34 50 1
2
0 3
0 1
Output
Cost of Optimal BST is 144
20
1

2) Karthik was given a problem in an online interview, but he cannot solve the solution help him solve the question. There are n students whose ids vary between 0 to 9 digits; two students can have same id's. You will be given x numbers which also vary from 0 to 9. You need to find the total number of student id's subsets which contains all the x numbers.

Input
333
1
3

Output
6

Post-Lab:

1) Define a group of length N as a sequence of N numbers, consisting of all the numbers from 1 to N in any order. An oppgroup of a group (let say P) is a sequence of numbers in which the ith number is the position of number i in the original group, $1 <= i <= N$.i.e., if group 2 5 1 4 3, oppgroupis 3 1 5 4 2. Given a number N, find the number of distinct groups of length N which cannot be distinguished from their oppgroups.

Input

1

3

Output

4

2)Given a string S of length N consisting of digits 1 to 9and an integer K. Determine the number of ways to partition the string S such that each segment value is less than K. If there is no way to perform partition on the string, then print 0.

Input
a)5 6
34212
b)2 21
11
c)5 22
34212
Output
a)1
b)2
c)3

LAB SESSION 14:

Pre-Lab:

1) Find out Graph traversals by using BFS and DFS to the following graph.
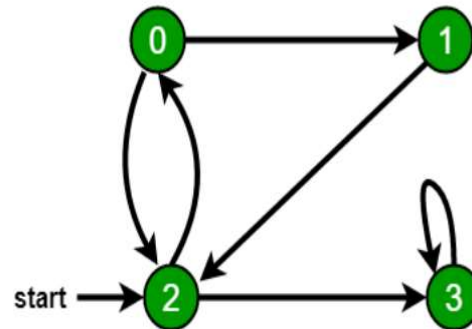
1) Dark Peace is volunteer in VISION 2K17.ChiefCO gave him a task to complete it before the CODEGEEKS which is on 11th march. ChiefCo asks DarkPeace to do the work as soon as possible. So, to complete the task as soon as possible Dark Peace asks you to help him. You will be given two set of length N and M. Your task is to find whether the subset is present in the first set whose sum of elements is equal to the member of the set. You must check for every member of the second set. Print Yes if subset is present and if not present print No and if the member exceeds the maximum sum of

   Input
   3 3
   1 7 4
   10 14 4
   Output
   No -1 Yes
   Explanation
   For first member no subset gives sum to 10 so we print No. For second since maximum sum is 12 and 14 is greater than 12 so we print -1. For last subset {4} exits whose sum is equal to 4 and hence we print Yes

Post-Lab:

1) The subset sum problem is an important problem in computer science. Below we will provide a simple algorithm for solving this problem. The challenge is to determine if there is some subset of numbers in an array that can sum up to some number S. These algorithms can both be implemented to solve Array Addition I and Array Addition.

Simple (Naive) solution
The algorithm for the exponential time, naive solution, is as follows: First we will generate every possible set (the power set), and then check if the sum of any of these sets equals the sum S. For example: arr = [1, 2, 3] sum = 5
All possible sets:[] [1] [2] [3] [1, 2] [1, 3] [2, 3] [1, 2, 3]
We can see that we can get a sum of 5 by adding the elements in the set [2, 3]. To generate all possible sets of an array, we will implement the following algorithm:
(1) The initial power set only contains the empty set: [[]]
(2) We loop through each element in the array and add it to every element in the powerset.
(3) Then we take the union of these two sets.
(4) Once we get the power set, we check to see if the sum equals our goal S.
Example
arr = [1, 2, 3] sum = 5 sets = [[]]
Step 1: Add 1 to the power set [[], [1]]
Step 2: Add 2 to the power set [[], [1], [1, 2], [2]]
Step 3: Add 3 to the power set [[], [1], [1, 2], [2], [1, 3], [2, 3], [1, 2, 3], [3]]

LAB SESSION 15:

Date of the Session:___/___/____   **Time of the Session:_____to_____**

Pre-Lab:

1) Write a recursive approach to get maximum profit value with Ex-tended knapsack problem.

Input
N = 5, P[] = {2, 7, 1, 5, 3}, C[] = {2, 5, 2, 3, 4}, W = 8, K = 2.
Output
12
Explanation:
Here, the maximum possible profit is when we take 2 items: item2 (P[1] = 7 and C[1] = 5) and item4 (P[3] = 5 and C[3] = 3). Hence, maximum profit = 7 + 5 = 12
Input
N = 5, P[] = {2, 7, 1, 5, 3}, C[] = {2, 5, 2, 3, 4}, W = 1, K = 2
Output
0
Explanation: All weights are greater than 1. Hence, no item can be picked.

1) Danny has a possible list of passwords of Manny's Facebook account. All passwords length is odd. But Danny knows that Manny is a huge fan of palindromes. So, his password and reverse of his password both should be in the list. You must print the length of Manny's password and its middle character.

   Note: The solution will be unique.

   Input

   4

   abc

   def

   feg

   cba

   Output:

   3

2) As a health expert, Vinay is keeping a close watch on the ongoing pandemic of coronavirus disease (COVID-19). He thought of a different situation where there are 26 types of viruses, named "aorona", "borona", "corona", …, "zorona". You are given a string S with length N. There are N people (numbered 1 through N) and for each valid i, the i-th person is infected by exactly one type of virus named Siorona (i.e., "corona" with the first letter replaced by the i-th character of S).

You should answer Q queries. In each query:

- You are given an integer C denoting the number of available isolation centers.
- Each isolation center has an infinite capacity, but with the restriction that two people infected with the same type of virus cannot stay in the same isolation center.
- There is also a pending queue with an infinite capacity and there are no restrictions on which people can be in the pending queue
- Initially, the isolation centers and pending queue are empty.
- Each of the N people should be placed in either the pending queue or one of the isolation centers.
- Since Vinay is busy finding a vaccine, he asks Swapnil to find a way to place the people in the pending queue and isolation centers such that the number of people in the pending queue is the smallest possible.
- Help Swapnil find the size of the pending queue in that case.

Input
1
20 2
stayinghomesaveslife
1
3

Output
6
0

Explanation
Example case 1: In the pending queue for the first query, there should be 2 people with "eorona", 2 with "sorona", 1 with "aorona" and 1 with "iorona".

<u>Post-Lab:</u>

1) Lisa is a school student teacher gave her an assignment to check whether the pattern is there or not in each text and, she mentioned that it is have solve by using Kmp algorithm so when a mismatch come other some matches in your search if she prints the number of letters that we can neglect before then she will get good marks so help her by writing a code.

Input
ABABDABACDABABCABAB
ABABCABAB

Output
we don"t match before 2 letters because they will match anyway
we don"t match before 0 letters because they will match anyway
we don"t match before 1 letter because they will match anyway
we don"t match before 0 letters because they will match anyway
Found pattern at index 10