VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
On

ANALYSIS AND DESIGN OF ALGORITHMS (23CS4PCADA)

Submitted by

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in partial fulfillment for the award of the degree of
BACHELOR OF ENGINEERING
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This is to certify that the Lab work entitled **"ANALYSIS AND DESIGN OF ALGORITHMS"** carried out by Hemanth Kumar R **(1BM23CS110)**, who is bonafide student of **B. M. S. College of Engineering**. It is in partial fulfillment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the year 2024-25. The Lab report has been approved as it satisfies the academic requirements in respect of Analysis and Design of Algorithms Lab - **(23CS4PCADA)** work prescribed for the said degree.

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Course outcomes:

CO1	Analyze time complexity of Recursive and Non-recursive algorithms using asymptotic notations.
CO2	Apply various design techniques for the given problem.
CO3	Apply the knowledge of complexity classes P, NP, and NP-Complete and prove certain problems are NP-Complete
CO4	Design efficient algorithms and conduct practical experiments to solve problems.

Lab program 1:

Write program to obtain the Topological ordering of vertices in a given digraph.

i)using dfs

CODE:

```
#include <stdio.h>
int n, a[10][10], res[10], s[10], top = 0;
void dfs(int, int, int[][10]);
void dfs_top(int, int[][10]);
int main()
{
printf("Enter the no. of nodes");
scanf("%d", &n);
int i, j;
for (i = 0; i < n; i++) {
for (j = 0; j < n; j++) {
scanf("%d", &a[i][j]);
}
}
dfs_top(n, a);
printf("Solution: ");
for (i = n - 1; i >= 0; i--) {
printf("%d ", res[i]);
}
return 0;
}
void dfs_top(int n, int a[][10]) {
int i;
for (i = 0; i < n; i++) {
s[i] = 0;
}
for (i = 0; i < n; i++) {
if (s[i] == 0) {
```

```
dfs(i, n, a);
}
}
}
void dfs(int j, int n, int a[][10]) {
s[j] = 1;
int i;
for (i = 0; i < n; i++) {
if (a[j][i] == 1 & s[i] == 0) {
dfs(i, n, a);
}
}
res[top++] = j;
}
```

OUTPUT:

```
PS D:\013 ADA>  & 'c:\Users\STUDENT\.vscode\extensions\ms-vscode.cpptools-1.24.5-win32-x64
-Out-ep1m3ff0.ymo' '--stderr=Microsoft-MIEngine-Error-hgfyi4bq.zgn' '--pid=Microsoft-MIEng
Enter the no. of nodes 6
0 0 1 1 0 0
0 0 0 1 1 0
0 0 0 1 0 1
0 0 0 0 0 1
0 0 0 0 0 1
0 0 0 0 0 0
Solution: 1 4 0 2 3 5
PS D:\013 ADA>
```

ii) using source removal method

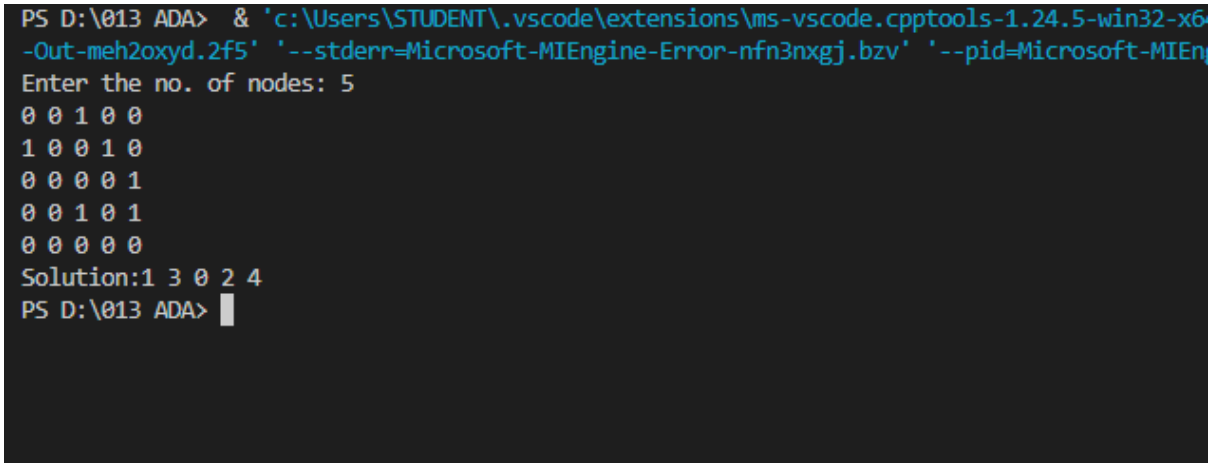
CODE:

```
#include<stdio.h>
int a[10][10],n,t[10],indegree[10];
int stack[10],top=-1;
void computeIndegree(int,int [][10]);
void tps_SourceRemoval(int,int [][10]);
int main(){
printf("Enter the no. of nodes: ");
```

```
scanf("%d",&n);
int i,j;
for(i=0;i<n;i++){
for(j=0;j<n;j++){
scanf("%d",&a[i][j]);
}
}
computeIndegree(n,a);
tps_SourceRemoval(n,a);
printf("Solution:");
for(i=0;i<n;i++){
printf("%d ",t[i]);
}
return 0;
}
void computeIndegree(int n,int a[][10]){
int i,j,sum=0;
for(i=0;i<n;i++){
sum=0;
for(j=0;j<n;j++){
sum=sum+a[j][i];
}
indegree[i]=sum;
}
}
void tps_SourceRemoval(int n,int a[][10]){
int i,j,v;
for(i=0;i<n;i++){
if(indegree[i]==0){
stack[++top]=i;
}
}
```

```
int k=0;
while(top!=-1){
v=stack[top--];
t[k++]=v;
for(i=0;i<n;i++){
if(a[v][i]!=0){
indegree[i]=indegree[i]-1;
if(indegree[i]==0){
stack[++top]=i;
}
}
}
}
}
```

OUTPUT:



LeetCode Program related to Topological sorting

CODE:

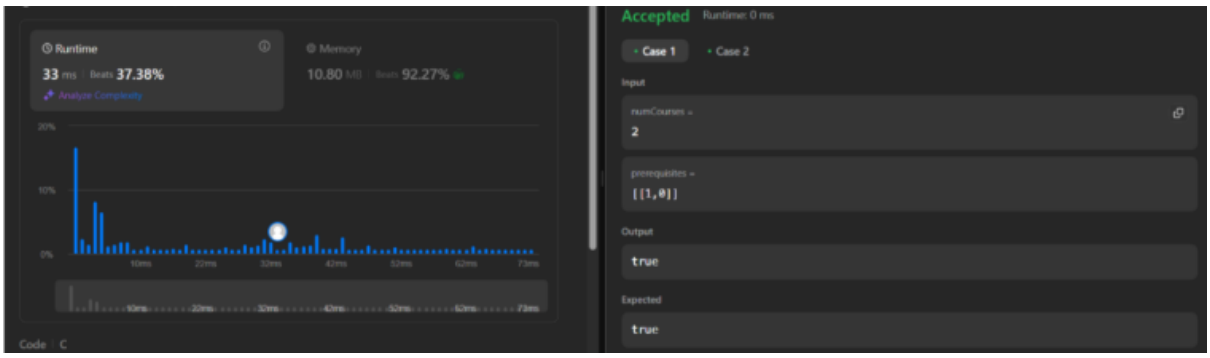
```
bool dfs(int course, int** prerequisites, int prerequisitesSize, int* prerequisitesColSize, int*
visited, int

numCourses) {

if (visited[course] == 1) {

return false;

}

if (visited[course] == 2) {

return true;

}

visited[course] = 1;

for (int i = 0; i < prerequisitesSize; i++) {
```



```
if (prerequisites[i][0] == course) {

int nextCourse = prerequisites[i][1];

if (!dfs(nextCourse, prerequisites, prerequisitesSize, prerequisitesColSize, visited,
numCourses)) {

return false;

}

}

}

visited[course] = 2;

return true;

}

bool canFinish(int numCourses, int** prerequisites, int prerequisitesSize, int*
prerequisitesColSize) {

int visited[numCourses];

for (int i = 0; i < numCourses; i++) {

visited[i] = 0;
```

```
}
for (int i = 0; i < numCourses; i++) {
if (visited[i] == 0) {
if (!dfs(i, prerequisites,prerequisitesSize, prerequisitesColSize, visited, numCourses)) {
return false;
}
}
}
return true;
}
```

OUTPUT:



Lab program 2:

Implement Johnson Trotter algorithm to generate permutations.

CODE:

```
#include <stdio.h>
#include <stdlib.h>
void swap(int* a, int* b) {
int temp = *a;
*a = *b;
*b = temp;
}
void generatePermutations(int arr[], int start, int end) {
if (start == end) {
for (int i = 0; i <= end; i++) {
printf("%d ", arr[i]);
}
printf("\n");
} else {
for (int i = start; i <= end; i++) {
swap(&arr[start], &arr[i]);
generatePermutations(arr, start + 1, end);
swap(&arr[start], &arr[i]); // backtrack
}
}
}
int main() {
int n;
printf("Enter the number of elements: ");
scanf("%d", &n);
```

```
int* arr = (int*)malloc(n * sizeof(int));
printf("Enter the elements: ");
for (int i = 0; i < n; i++) {
scanf("%d", &arr[i]);
}
generatePermutations(arr, 0, n - 1);
free(arr);
return 0;
}
```

OUTPUT:

```
PS D:\013 ADA>  & 'c:\Users\STUDENT\.vscode\extensions\ms-vscode.cpptools-1.24.5-win32-x64\debugAdapters\bin\Wi
-Out-jbouobin.0bh' '--stderr=Microsoft-MIEngine-Error-2dhrtqgc.w2m' '--pid=Microsoft-MIEngine-Pid-w4atb5is.vzb'
Enter the number of elements: 4
Enter the elements: 1 2 3 4
1 2 3 4
1 2 4 3
1 3 2 4
1 3 4 2
1 4 3 2
1 4 2 3
2 1 3 4
2 1 4 3
2 3 1 4
2 3 4 1
2 4 3 1
2 4 1 3
3 2 1 4
3 2 4 1
3 1 2 4
3 1 4 2
3 4 1 2
3 4 2 1
4 2 3 1
4 2 1 3
4 3 2 1
4 3 1 2
4 1 3 2
4 1 2 3
PS D:\013 ADA>
```

Lab program 3:

Sort a given set of N integer elements using Merge Sort technique and compute its time taken. Run the program for different values of N and record the time taken to sort.

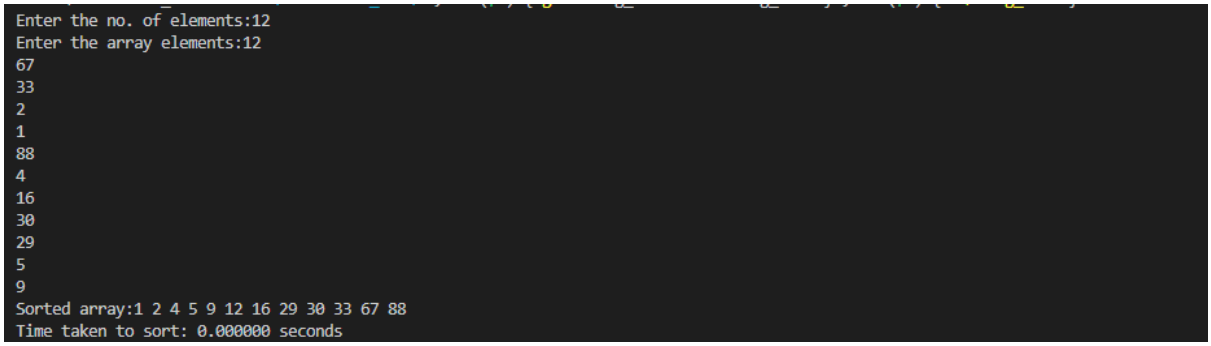
CODE:

```
#include<stdio.h>
#include<time.h>

int a[20],n;
void simple_sort(int [],int,int,int);
void merge_sort(int a[],int low, int high){
   if(low<high){
      int mid=(low+high)/2;
      merge_sort(a,low,mid);
      merge_sort(a,mid+1,high);
      simple_sort(a,low,mid,high);
   }
}
void simple_sort(int a[],int low, int mid, int high){
   int i=low,j=mid+1,k=low;
   int c[n];
   while(i<=mid && j<=high){
      if(a[i]<a[j]){
         c[k++]=a[i];
         i++;
      }else{
         c[k++]=a[j];
         j++;
      }
   }
```

```
    while(i<=mid){
        c[k++]=a[i];
        i++;
    }
    while(j<=high){
        c[k++]=a[j];
        j++;
    }
    for(i=low;i<=high;i++){
        a[i]=c[i];
    }
}
int main()
{
    int i;
    clock_t start, end;
    double time_taken;
    printf("Enter the no. of elements:");
    scanf("%d", &n);
    printf("Enter the array elements:");
    for (i = 0; i < n; i++) {
        scanf("%d", &a[i]);
    }
    start = clock();
    merge_sort(a, 0, n - 1);
    end = clock();
    time_taken = (double)(end - start) / CLOCKS_PER_SEC;
    printf("Sorted array:");
    for (i = 0; i < n; i++) {
```

```
        printf("%d ", a[i]);
    }
    printf("\n");
    printf("Time taken to sort: %f seconds\n", time_taken);
    return 0;
}
```

OUTPUT:



Lab program 4:

Sort a given set of N integer elements using Quick Sort technique and compute its time taken.

CODE:

```
#include <stdio.h>
#include <stdlib.h>  // for rand()
#include <time.h>    // for clock()

#define MAX 5000

void quicksort(int[], int, int);
int partition(int[], int, int);

int main() {
   int i, n, a[MAX], ch;
   clock_t start, end;

   while (1) {
      printf("\nEnter the number of elements: ");
      scanf("%d", &n);

      // Generate random array elements
      for (i = 0; i < n; i++) {
         a[i] = rand() % 200;  // Random number between 0 and 199
      }

      // Display the random array
      printf("The random generated array is:\n");
      for (i = 0; i < n; i++) {
         printf("%d ", a[i]);
      }
      printf("\n");
```

```
        // Measure the time taken for sorting
        start = clock();
        quicksort(a, 0, n - 1);
        end = clock();

        // Display the sorted array
        printf("\nThe sorted array elements are:\n");
        for (i = 0; i < n; i++) {
            printf("%d ", a[i]);
        }
        printf("\n");

        // Calculate and print the time taken for sorting
        printf("Time taken = %f seconds\n", (double)(end - start) / CLOCKS_PER_SEC);

        // Ask user if they want to continue
        printf("\nDo you wish to continue? (0/1): ");
        scanf("%d", &ch);
        if (ch == 0) {
            break;
        }
    }

    return 0;
}

// QuickSort function
void quicksort(int a[], int low, int high) {
    if (low < high) {
        int mid = partition(a, low, high);
        quicksort(a, low, mid - 1);  // Recursively sort the left part
        quicksort(a, mid + 1, high); // Recursively sort the right part
```

```
    }
}

// Partition function: Returns the partition index
int partition(int a[], int low, int high) {
    int pivot = a[low]; // Pivot is the first element in the array
    int i = low + 1;
    int j = high;
    int temp;

    while (i <= j) {
        // Find an element greater than the pivot
        while (i <= high && a[i] <= pivot) {
            i++;
        }

        // Find an element less than the pivot
        while (a[j] > pivot) {
            j--;
        }

        // If there are elements to swap, swap them
        if (i < j) {
            temp = a[i];
            a[i] = a[j];
            a[j] = temp;
        }
    }

    // Swap the pivot element with a[j]
    temp = a[low];
    a[low] = a[j];
```

```
    a[j] = temp;

    return j;  // Return the partition index
}
```

OUTPUT:

Lab program 5:

Sort a given set of N integer elements using Heap Sort technique and compute its time taken.

CODE:

```
#include<stdio.h>
#include<conio.h>
#include<time.h>

void heapcom(int a[],int n)
{
        int i,j,k,item;
        for(i=1;i<=n;i++)
        {
                item=a[i];
                j=i;
                k=j/2;
                while(k!=0 && item>a[k])
                {
                        a[j]=a[k];
                        j=k;
                        k=j/2;
                }
                a[j]=item;
        }
}
void adjust(int a[],int n)
{
        int item,i,j;
        j=1;
        item=a[j];
```

```
        i=2*j;
        while(i<n)
        {
                if((i+1)<n)
                {
                        if(a[i]<a[i+1])
                        i++;
                }
                if(item<a[i])
                {
                        a[j]=a[i];
                        j=i;
                        i=2*j;
                }
                else
                break;
        }
        a[j]=item;
}
void heapsort(int a[],int n)
{
        int i,temp;
        heapcom(a,n);
        for(i=n;i>=1;i--)
        {
                temp=a[1];
                a[1]=a[i];
                a[i]=temp;
                adjust(a,i);
```

```
        }
}
void main()
        {
          int i,n,a[20],ch=1;
          clock_t start,end;
          while(ch)
           {
                printf("\n enter the number of elements to sort\n");
                scanf("%d",&n);
                printf("\n enter the elements to sort\n");
                for(i=1;i<=n;i++)
                   scanf("%d",&a[i]);
                start=clock();
                heapsort(a,n);
                end=clock();
                printf("\n the sorted list of elemnts is\n");
                for(i=1;i<=n;i++)
                   printf("%d\n",a[i]);
                printf("\n Time taken is %lf CPU cycles\n",(end-start)/CLK_TCK);
                printf("do u wish to run again (0/1)\n");
                scanf("%d",&ch);
        }
}
```

OUTPUT:

```
 enter the number of elements to sort
5

 enter the elements to sort
8 5 6 3 1

 the sorted list of elemnts is
1
3
5
6
8

 Time taken is 0.000000 CPU cycles
do u wish to run again (0/1)
0
```

Lab program 6:

Implement 0/1 Knapsack problem using dynamic programming.

CODE:

```
#include<stdio.h>
int i,j,n,c,w[10],p[10],v[10][10];
void knapsack(int n,int w[10],int p[10],int c)
{
int max(int,int);
for(i=0;i<=n;i++)
{
for(j=0;j<=c;j++)
{
if(i==0||j==0)
v[i][j]=0;
else if(w[i]>j)
v[i][j]=v[i-1][j];
else
v[i][j]=max(v[i-1][j],(v[i-1][j-w[i]]+p[i]));

}
}
printf("\n\n Maximum Profit is : %d ",v[n][c]);
printf("\n\n\n Table : \n\n");
for(i=0;i<=n;i++)
{
for(j=0;j<=c;j++)
{
printf("\t%d",v[i][j]);
}
```

```
printf("\n");
}
}
int max(int a,int b)
{
return ((a>b)?a:b);
}
void main()
{
printf("\n Enter the no. of objects : ");
scanf("%d",&n);
printf("\n Enter the weights : ");
for(i=1;i<=n;i++)
{
scanf("%d",&w[i]);
}
printf("\n Enter the Profits : ");
for(i=1;i<=n;i++)
{
scanf("%d",&p[i]);
}
printf("\n Enter the capacity : ");
scanf("%d",&c);
knapsack(n,w,p,c);
}
```

OUTPUT:

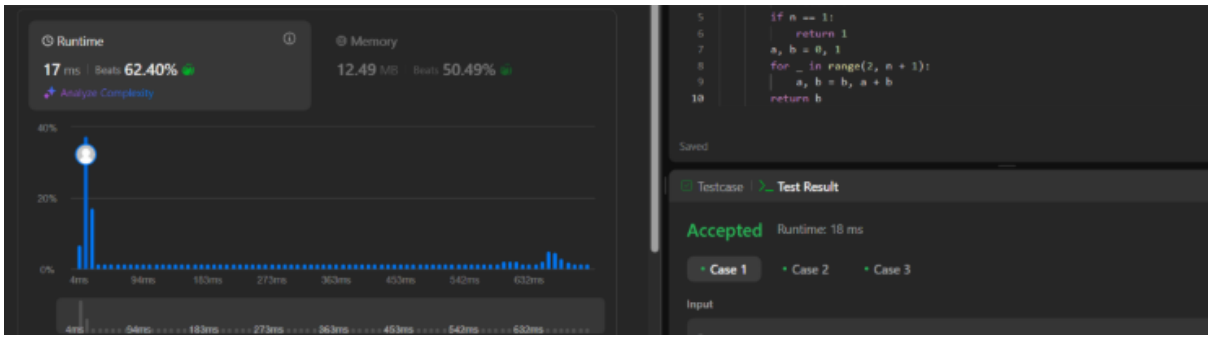
```
 Enter the no. of objects : 4

 Enter the weights : 2
1
3
2

 Enter the Profits : 12
10
20
15

 Enter the capacity : 5


 Maximum Profit is : 37


 Table :

       0       0       0       0       0       0
       0       0       12      12      12      12
       0       10      12      22      22      22
       0       10      12      22      30      32
       0       10      15      25      30      37
```

LeetCode Program related to Knapsack problem or Dynamic Programming.

CODE:

```
class Solution(object):
def fib(self, n):
if n == 0:
return 0
if n == 1:
return 1
a, b = 0, 1
for _ in range(2, n + 1):
a, b = b, a + b
return b
```

OUTPUT:



Lab program 7:

Implement All Pair Shortest paths problem using Floyd's algorithm.

CODE:

```
#include <stdio.h>
int a[10][10],D[10][10],n;
void floyd(int [][10],int);
int min(int,int);
int main()
{
printf("Enter the no. of vertices:");
scanf("%d",&n);
printf("Enter the cost adjacency matrix:\n");
int i,j;
for(i=0;i<n;i++){
for(j=0;j<n;j++){
scanf("%d",&a[i][j]);
}
}
floyd(a,n);
printf("Distance Matrix:\n");
for(i=0;i<n;i++){
for(j=0;j<n;j++){
printf("%d ",D[i][j]);
}
printf("\n");
}
return 0;
}
```

```
void floyd(int a[][10],int n){
int i,j,k;
for(i=0;i<n;i++){
for(j=0;j<n;j++){
D[i][j]=a[i][j];
}
}

for(k=0;k<n;k++){
for(i=0;i<n;i++){
for(j=0;j<n;j++){
D[i][j]=min(D[i][j],(D[i][k]+D[k][j]));
}
}
}
}

int min(int a,int b){
if(a<b){
return a;
}else{
return b;
}
}
```

OUTPUT:

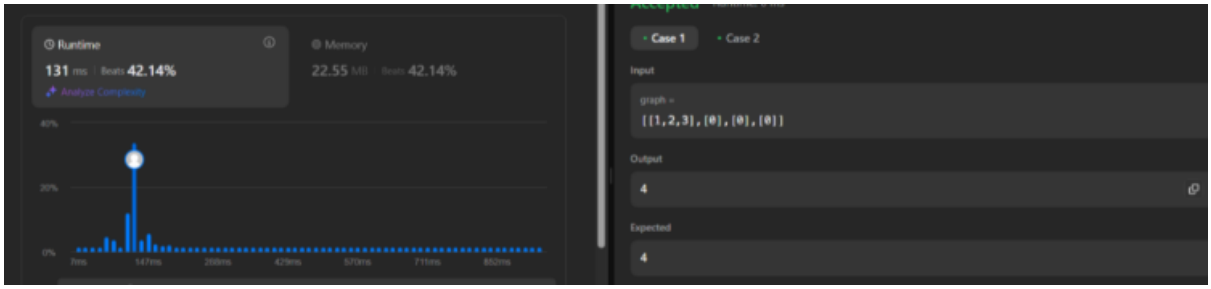

Enter the no. of vertices:4
Enter the cost adjacency matrix:
0
99
3
99
2
0
99
99
99
6
0
1
7
99
99
0
Distance Matrix:
0 9 3 4
2 0 5 6
8 6 0 1
7 16 10 0

LeetCode Program related to shortest distance calculation.

CODE:

```
class Solution:
def shortestPathLength(self, graph: List[List[int]]) -> int:
n=len(graph)
queue=deque([(i,1<<i) for i in range(n)])
seen=set(queue)
ans=0
while queue:
for _ in range(len(queue)):
u,m=queue.popleft()
if m==(1<<n)-1:
return ans
for v in graph[u]:
if (v,m|1<<v) not in seen:
queue.append((v,m|1<<v))
seen.add((v,m|1<<v))
ans+=1
```

OUTPUT:



Lab program 8:

Find Minimum Cost Spanning Tree of a given undirected graph using Prim's algorithm.

CODE:

```
#include<stdio.h>
int cost[10][10], n, t[10][2], sum;
void prims(int cost[10][10], int n);
int main() {
int i, j;
printf("Enter the number of vertices: ");
scanf("%d",&n);
printf("Enter the cost adjacency matrix:\n");
for (i = 0; i <n; i++) {
for (j = 0; j <n; j++) {
scanf("%d",&cost[i][j]);
}
}
prims(cost, n);
printf("Edges of the minimal spanning tree:\n");
for (i = 0; i <n - 1; i++) {
printf("(%d, %d) ", t[i][0], t[i][1]);
}
printf("\nSum of minimal spanning tree: %d\n", sum);
return 0;
}
void prims(int cost[10][10], int n) {
int i, j, u, v;
int min, source;
int p[10], d[10], s[10];
min = 999;
```

```
source = 0;


for (i = 0; i <n; i++) {
d[i] = cost[source][i];
s[i] = 0;
p[i] = source;
}
s[source] = 1;
sum = 0;
int k = 0;
for (i = 0; i <n - 1; i++) {
min = 999;
u = -1;
for (j = 0; j <n; j++) {
if (s[j] == 0 && d[j] <min) {
min = d[j];
u = j;
}
}
if (u != -1) {
t[k][0] = u;
t[k][1] = p[u];
k++;
sum += cost[u][p[u]];
s[u] = 1;
for (v = 0; v <n; v++) {
if (s[v] == 0 && cost[u][v] <d[v]) {
d[v] = cost[u][v];
p[v] = u;
```

```
}
}
}


}
}
```

OUTPUT:


nter the number of vertices: 5
nter the cost adjacency matrix:
dges of the minimal spanning tree:
1, 0) (2, 0) (3, 0) (4, 0)
um of minimal spanning tree: 10

Find Minimum Cost Spanning Tree of a given undirected graph using Kruskal's algorithm.

CODE:

```
#include<stdio.h>
int cost[10][10], n, t[10][2], sum;
void kruskal(int cost[10][10], int n);
int find(int parent[10], int i);
int main() {
int i, j;
printf("Enter the number of vertices: ");
scanf("%d", &n);
printf("Enter the cost adjacency matrix:\n");
for (i = 0; i < n; i++) {
for (j = 0; j < n; j++) {
scanf("%d", &cost[i][j]);
}
}
kruskal(cost, n);
printf("Edges of the minimal spanning tree:\n");

for (i = 0; i < n - 1; i++) {
printf("(%d, %d) ", t[i][0], t[i][1]);
}
printf("\nSum of minimal spanning tree: %d\n", sum);
return 0;
}
void kruskal(int cost[10][10], int n) {
int min, u, v, count, k;
int parent[10];
k = 0;
```

```
sum = 0;
for (int i = 0; i < n; i++) {
parent[i] = i;
}
count = 0;
while (count < n - 1) {
min = 999;
u = -1;
v = -1;
for (int i = 0; i < n; i++) {
for (int j = 0; j < n; j++) {
if (find(parent, i) != find(parent, j) && cost[i][j] < min) {
min = cost[i][j];
u = i;
v = j;
}
}
}
int root_u = find(parent, u);
int root_v = find(parent, v);

if (root_u != root_v) {
parent[root_u] = root_v;
t[k][0] = u;
t[k][1] = v;
sum += min;
k++;
count++;
}
```

```
}
}
int find(int parent[10], int i) {
while (parent[i] != i) {
i = parent[i];
}
return i;
}
```

OUTPUT:

Lab program 9:

Implement Fractional Knapsack using Greedy technique.

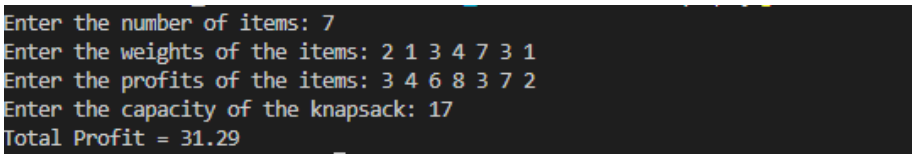
CODE:

```
#include <stdio.h>
#define MAX 100
void fractionalKnapsack(int n, float weight[], float profit[], float capacity) {
   float ratio[MAX],
   temp; int i, j;

   for (i = 0; i < n; i++)
   ratio[i] = profit[i] / weight[i];

   for (i = 0; i < n - 1; i++) {
   for (j = i + 1; j < n; j++) {
   if (ratio[i] < ratio[j]) {
   temp = ratio[i]; ratio[i] = ratio[j]; ratio[j] = temp;
   temp = weight[i]; weight[i] = weight[j]; weight[j] = temp;
   temp = profit[i]; profit[i] = profit[j]; profit[j] = temp;
   }
   }
   }

   float totalProfit = 0;
   for (i = 0; i < n; i++) {

   if (capacity >= weight[i]) {
   capacity -= weight[i];
   totalProfit += profit[i];
   } else {
```

```
totalProfit += ratio[i] * capacity;
break;
}
}
printf("Total Profit = %.2f\n", totalProfit);

}

int main() {
    int n;
    float weight[MAX], profit[MAX], capacity;
    printf("Enter the number of items: ");
    scanf("%d", &n);

    printf("Enter the weights of the items: ");
    for (int i = 0; i < n; i++) {
        scanf("%f", &weight[i]);
    }

    printf("Enter the profits of the items: ");
    for (int i = 0; i < n; i++) {
        scanf("%f", &profit[i]);
    }

    printf("Enter the capacity of the knapsack: ");
    scanf("%f", &capacity);

    fractionalKnapsack(n, weight, profit, capacity);
```

```
    return 0;
}
```

OTUPUT:



LeetCode Program related to Greedy Technique algorithms.

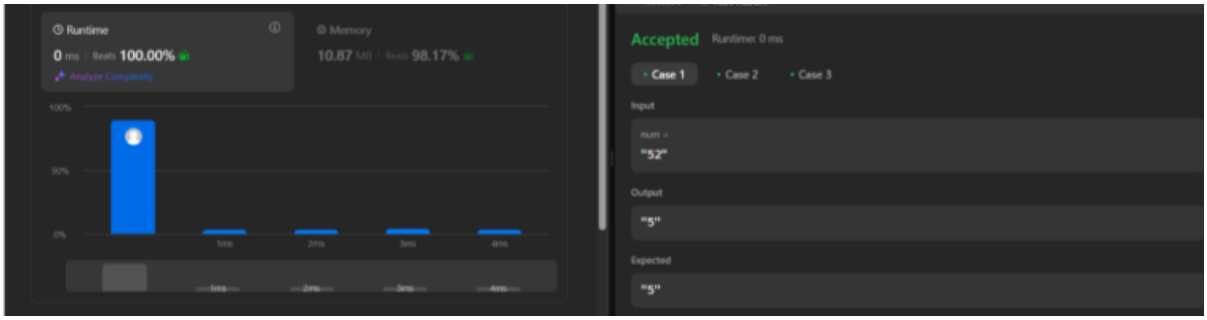
CODE:

```
char* largestOddNumber(char* num) {
int len = strlen(num);
```



```
for (int i = len - 1; i >= 0; i--) {
if ((num[i] - '0') % 2 == 1) {
num[i + 1] = '\0'; // Truncate string at that position
return num; // Return the longest odd-suffix (greedy)
}
}

return ""; // No odd digit found
}
```

OUTPUT:



Lab program 10:

From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijkstra's algorithm.

CODE:

```
#include<stdio.h>
void main()
{
int i,j,n,v,k,min,u,c[20][20],s[20],d[20];
printf("\n Enter the no. of vertices : ");
scanf("%d",&n);
printf("\n Enter the cost adjacency matrix : ");
printf("\n Enter 999 for no edge ");
for(i=1;i<=n;i++)
{
for(j=1;j<=n;j++)
{
scanf("%d",&c[i][j]);
}
}
printf("\n Enter the source vertex : ");
scanf("%d",&v);
for(i=1;i<=n;i++)
{
s[i]=0;
d[i]=c[v][i];
}
d[v]=0;
s[v]=1;
for(k=2;k<=n;k++)
{
```

```
min=999;
for(i=1;i<=n;i++){
   if((s[i]==0)&(d[i]<min)){
      min=d[i];
      u=i;
}
}
s[u]=1;
for(i=1;i<=n;i++)
{

if(s[i]==0)
{
if(d[i]>(d[u]+c[u][i]))
{
d[i]=d[u]+c[u][i];
}
}

}
}
printf("\n The shortest distance from %d is ",v);
for(i=1;i<=n;i++)
{
printf("\n %d -->; %d = %d ",v,i,d[i]);
}
}
```

OUTPUT:

```
 Enter the no. of vertices : 5

 Enter the cost adjacency matrix :
 Enter 999 for no edge 999
7
3
999
999
7
999
2
5
4
3
2
999
4
999
999
5
4
999
6
999
4
999
6
999

 Enter the source vertex : 1

 The shortest distance from 1 is
 1 -->; 1 = 0
 1 -->; 2 = 5
 1 -->; 3 = 3
 1 -->; 4 = 7
 1 -->; 5 = 9
```

Lab program 11:

Implement “N-Queens Problem” using Backtracking.

CODE:

```
#include<stdio.h>
#include<conio.h>
#include<math.h>
int x[20],count=1;
void queens(int,int);
int place(int,int);

void main()
{
	int n,k=1;
	printf("\n enter the number of queens to be placed\n");
	scanf("%d",&n);
	queens(k,n);
}
void queens(int k,int n)
{
	int i,j;
	for(j=1;j<=n;j++)
	{
		if(place(k,j))
		{
			x[k]=j;
			if(k==n)
			{
				printf("\n %d solution",count);
				count++;
```

```
                    for(i=1;i<=n;i++)
                    printf("\n \t %d row <---> %d column",i,x[i]);
                    getch();
                }
                else
                queens(k+1,n);
            }
        }
}
int place(int k,int j)
{
        int i;
        for(i=1;i<k;i++)
        if((x[i]==j) || (abs(x[i]-j))==abs(i-k))
        return 0;
        return 1;
}
```

OUTPUT:

```
 enter the number of queens to be placed
4

 1 solution
        1 row <---> 2 column
        2 row <---> 4 column
        3 row <---> 1 column
        4 row <---> 3 column
 2 solution
        1 row <---> 3 column
        2 row <---> 1 column
        3 row <---> 4 column
        4 row <---> 2 column
```