VISVESVARAYA TECHNOLOGICAL UNIVERSITY

“JnanaSangama”, Belgaum -590014, Karnataka.

LAB REPORT
on

Analysis and Design of Algorithms

Submitted by

Preeti T Korishettar (1BM22CS208)

in partial fulfillment for the award of the degree of
BACHELOR OF ENGINEERING
in
COMPUTER SCIENCE AND ENGINEERING

B.M.S. COLLEGE OF ENGINEERING
(Autonomous Institution under VTU)
BENGALURU-560019
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B. M. S. College of Engineering,

Bull Temple Road, Bangalore 560019

(Affiliated to Visvesvaraya Technological University, Belgaum)

Department of Computer Science and Engineering

CERTIFICATE

This is to certify that the Lab work entitled "**Analysis and Design of Algorithms**" carried out by **Preeti T Korishettar (1BM22CS208),** 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 academic semester April-2024 to August-2024. The Lab report has been approved as it satisfies the academic requirements in respect of an **Analysis and Design of Algorithms (23CS4PCADA)** work prescribed for the said degree.

M Lakshmi Neelima	**Dr. Jyothi S Nayak**
Assistant Professor	Professor and Head
Department of CSE	Department of CSE
BMSCE, Bengaluru	BMSCE, Bengaluru

Index Sheet

	Prim’s algorithm. ➢ Find Minimum Cost Spanning Tree of a given undirected graph using Kruskal’s algorithm.	
12	Implement Fractional Knapsack using Greedy technique.	
13	From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijkstra’s algorithm.	
14	Implement “N-Queens Problem” using Backtracking.	

Course Outcome

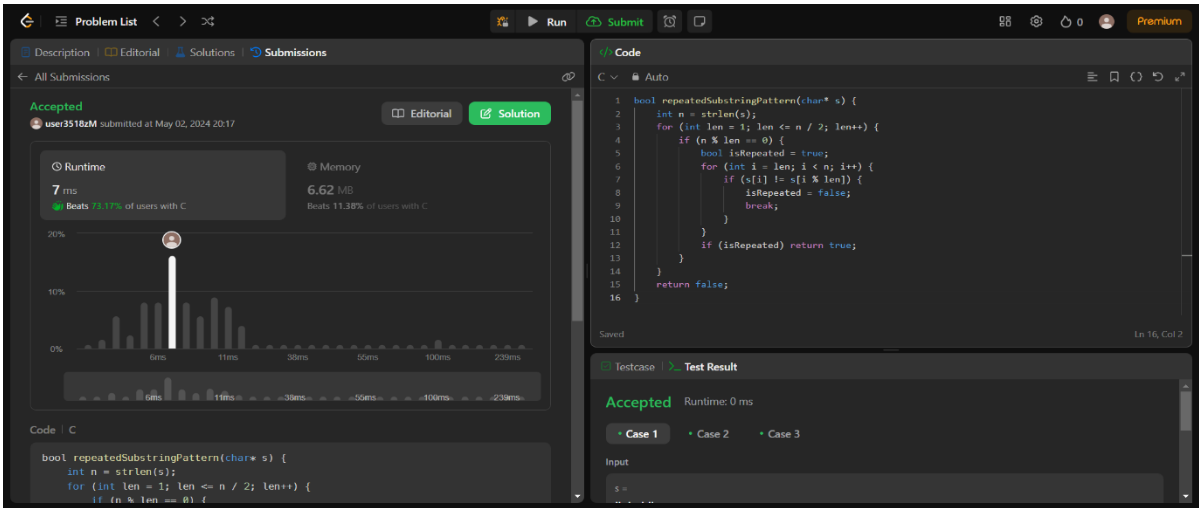
CO1	Analyze time complexity of Recursive and Non-recursive algorithms using asymptotic notations.
CO2	Apply various design techniques for the given problem.
CO3	Apply the knowledge of complexity classes P, NP, and NP-Complete and prove certain problems are NP-Complete
CO4	Design efficient algorithms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

1.Leetcode exercises on Stacks, Queues, Circular Queues, Priority Queues.

Repeated substring pattern

```
bool repeatedSubstringPattern(char* s) {
    int n = strlen(s);
    for (int len = 1; len <= n / 2; len++) {
        if (n % len == 0) {
            bool isRepeated = true;
            for (int i = len; i < n; i++) {
                if (s[i] != s[i % len]) {
                    isRepeated = false;
                    break;
                }}
            if (isRepeated) return true;
        } }
    return false;}
```

OUTPUT:



Accepted

user3518zM submitted at May 02, 2024 20:17

Runtime

7 ms

Beats 73.17% of users with C

Memory

6.62 MB

Beats 11.38% of users with C

Code | C

```
bool repeatedSubstringPattern(char* s) {
    int n = strlen(s);
    for (int len = 1; len <= n / 2; len++) {
        if (n % len == 0) {
```

```
bool repeatedSubstringPattern(char* s) {
    int n = strlen(s);
    for (int len = 1; len <= n / 2; len++) {
        if (n % len == 0) {
            bool isRepeated = true;
            for (int i = len; i < n; i++) {
                if (s[i] != s[i % len]) {
                    isRepeated = false;
                    break;
                }
            }
            if (isRepeated) return true;
        }
    }
    return false;
}
```

Saved

Ln 16, Col 2

Accepted Runtime: 0 ms

Case 1 • Case 2 • Case 3

Input

s =

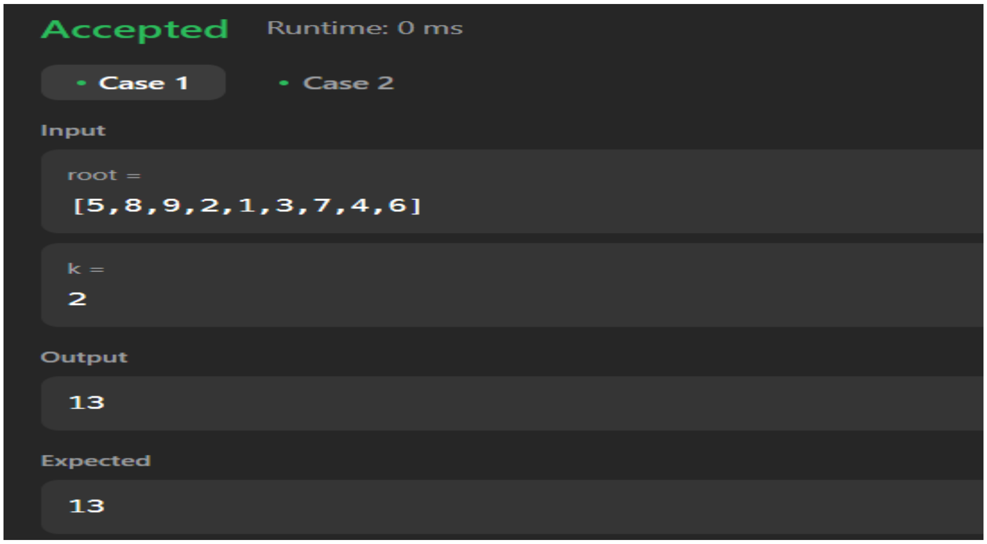
2 .Leetcode exercises on DFS, BFS.

Kth largest element in the tree

```
/**
 * Definition for a binary tree node.
 * struct TreeNode {
 *     int val;
 *     struct TreeNode *left;
 *     struct TreeNode *right;
 * };
 */
void dfs(struct TreeNode* root, int level, long long levelSum[])
 {
    if (root == NULL)
        return;
    levelSum[level] += root->val;
    dfs(root->left, level + 1, levelSum);
    dfs(root->right, level + 1, levelSum);
}
long long kthLargestLevelSum(struct TreeNode* root, int k)
{
    if (root == NULL)
        return -1; // If the tree is empty

    long long* levelSum = (long long*)calloc(1000, sizeof(long long));

    dfs(root, 0, levelSum);
    long long* levelSums = (long long*)malloc(1000 * sizeof(long long));

    int numLevels = 0;
    for (int i = 0; i < 1000 && levelSum[i] != 0; ++i)
   {
        levelSums[numLevels++] = levelSum[i];
    }

    for (int i = 0; i < numLevels - 1; ++i) {
        for (int j = i + 1; j < numLevels; ++j) {
            if (levelSums[i] < levelSums[j]) {
                long long temp = levelSums[i];
                levelSums[i] = levelSums[j];
                levelSums[j] = temp;
            }
        }
    }
   if (k <= numLevels) {
```

```
 return levelSums[k - 1];
    }
    else {
        return -1; // If there are fewer than k levels in the tree
    }
}
```

OUTPUT:



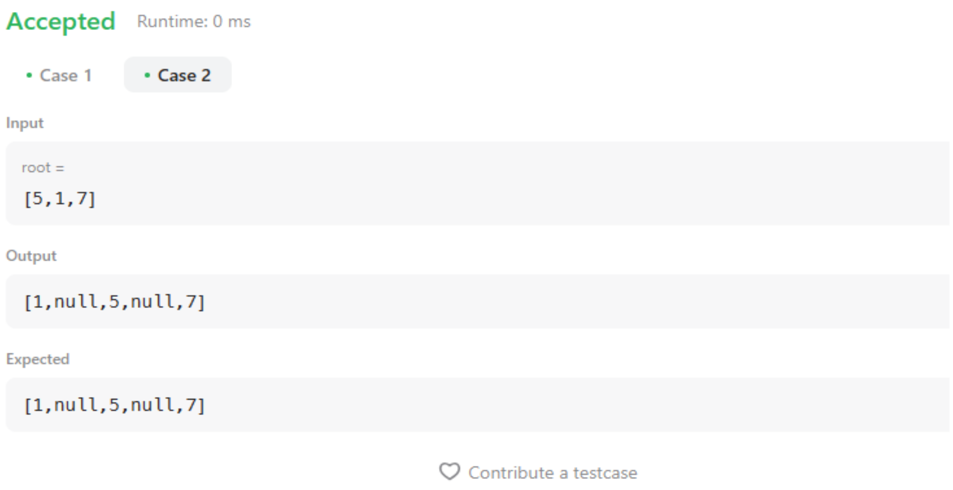
```
Accepted    Runtime: 0 ms
• Case 1    • Case 2
Input
root =
[5,8,9,2,1,3,7,4,6]
k =
2
Output
13
Expected
13
```

3.Leetcode exercises on Trees and Graphs.

Increasing order search tree.

```
/**

 * Definition for a binary tree node.

 * struct TreeNode {
 *     int val;
 *     struct TreeNode *left;
 *     struct TreeNode *right;
 * };
 */
struct TreeNode* increasingBST(struct TreeNode* root) {
    if (!root)
        return root;

    struct TreeNode* lft = increasingBST(root->left);
    if (lft){
        struct TreeNode* temp = lft;
        while (temp->right)
        temp = temp->right;
        root->left = NULL;
        temp->right = root;
        root->right = increasingBST(root->right);
        root = lft;
    }
    else
        root->right = increasingBST(root->right);
 return root;
}
```

Output:



Accepted Runtime: 0 ms

• Case 1 • Case 2

Input

root =

```
[5,1,7]
```

Output

```
[1,null,5,null,7]
```

Expected

```
[1,null,5,null,7]
```

WEEK -04

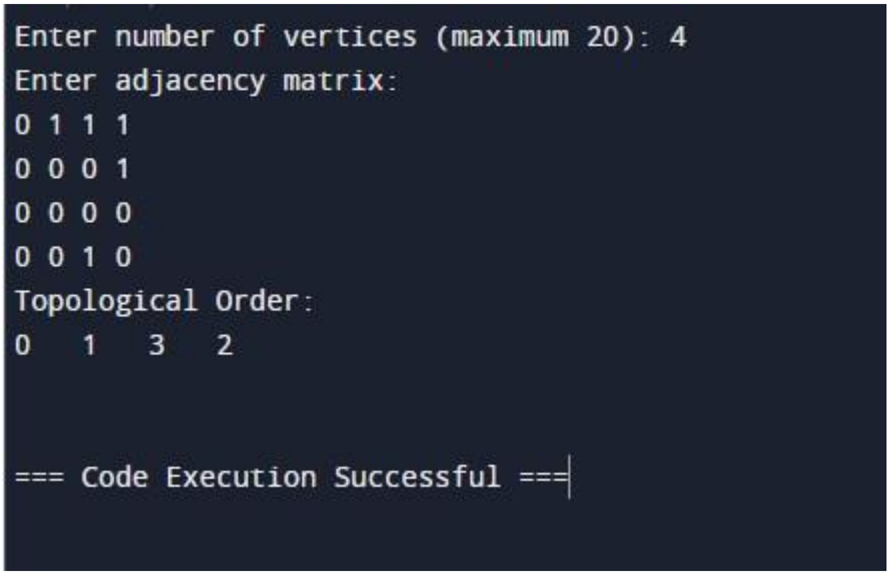
Program to obtain the Topological ordering of vertices in a given digraph

1)DFS Technique

```
#include<stdio.h>
#include<stdlib.h>
#define MAX 100
int graph[MAX][MAX];
int visited[MAX];
int stack[MAX];
int top = -1;
int num_nodes;
void initializeGraph() {
    int i, j;
    for (i = 0; i < num_nodes; i++) {
        visited[i] = 0;
        stack[i] = -1;
        for (j = 0; j < num_nodes; j++) {
            graph[i][j] = 0;
        }}}
void addEdge(int from, int to) {
    graph[from][to] = 1;
}
void dfs(int node) {
    int i;
    visited[node] = 1;
    for (i = 0; i < num_nodes; i++) {
        if (graph[node][i] && !visited[i]) {
            dfs(i);
        }} stack[++top] = node;}
```

```
void topologicalSort() {
    int i;
    for (i = 0; i < num_nodes; i++) {
        if (!visited[i]) {
            dfs(i);}
    }
    printf("Topological Sorting Order: ");
    for (i = top; i >= 0; i--) {
        printf("%d ", stack[i]);
    }
    printf("\n");
}
int main() {
    int num_edges, i, from, to;
    printf("Enter the number of vertices: ");
    scanf("%d", &num_nodes);
    initializeGraph();
    printf("Enter the number of edges: ");
    scanf("%d", &num_edges);
    printf("Enter the edges (from to): \n");
    for (i = 0; i < num_edges; i++) {
        scanf("%d %d", &from, &to);
        addEdge(from, to);
    }
    topologicalSort();
    return 0;
}
```

OUTPUT:



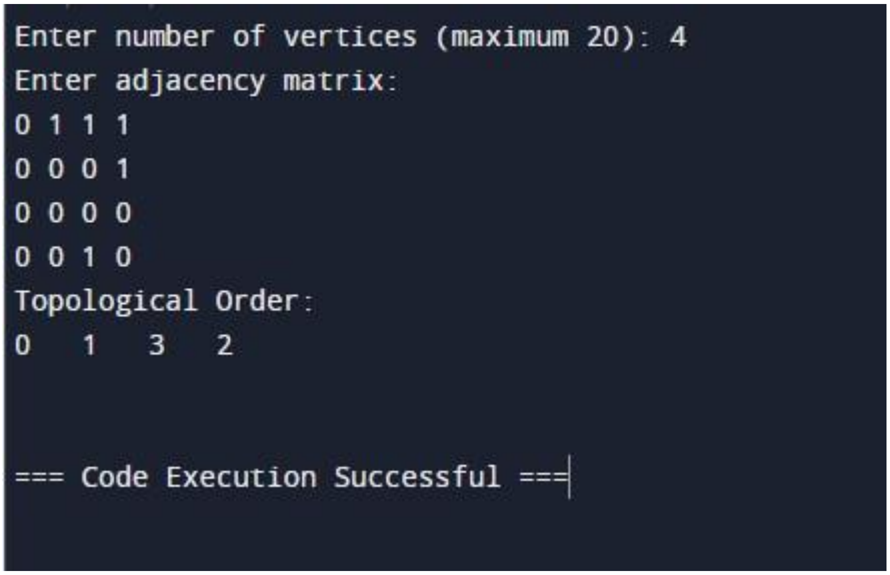
```
Enter number of vertices (maximum 20): 4
Enter adjacency matrix:
0 1 1 1
0 0 0 1
0 0 0 0
0 0 1 0
Topological Order:
0   1   3   2


=== Code Execution Successful ===
```

2)Source Removal Technique

```
#include<stdio.h>
#include<stdlib.h>
#define MAX 100//source removal method
int graph[MAX][MAX];
int visited[MAX];
int indegree[MAX];
int num_nodes;
void initializeGraph() {
    int i, j;
    for (i = 0; i < num_nodes; i++) {
        visited[i] = 0;
        indegree[i] = 0;
        for (j = 0; j < num_nodes; j++) {
            graph[i][j] = 0;
        }
    }
```

```
}
void addEdge(int from, int to) {
    graph[from][to] = 1;
    indegree[to]++;
}
void topologicalSort() {
    int i, j, k;
    for (i = 0; i < num_nodes; i++) {
        // Find a node with indegree 0
        for (j = 0; j < num_nodes; j++) {
            if (!visited[j] && indegree[j] == 0) {
                visited[j] = 1;
                printf("%d ", j);
                // Remove edges starting from this node
                for (k = 0; k < num_nodes; k++) {
                    if (graph[j][k]) {
                        indegree[k]--;}}
                break;
            }}}
    printf("\n");
}
int main() {
    int num_edges, i, from, to;
    printf("Enter the number of nodes: ");
    scanf("%d", &num_nodes);
    initializeGraph();
    printf("Enter the number of edges: ");
    scanf("%d", &num_edges);
    printf("Enter the edges (from to): \n");
    for (i = 0; i < num_edges; i++) {
        scanf("%d %d", &from, &to);
        addEdge(from, to);
    }
    printf("Topological Sorting Order: ");
    topologicalSort();
    return 0;
}
```

OUTPUT:



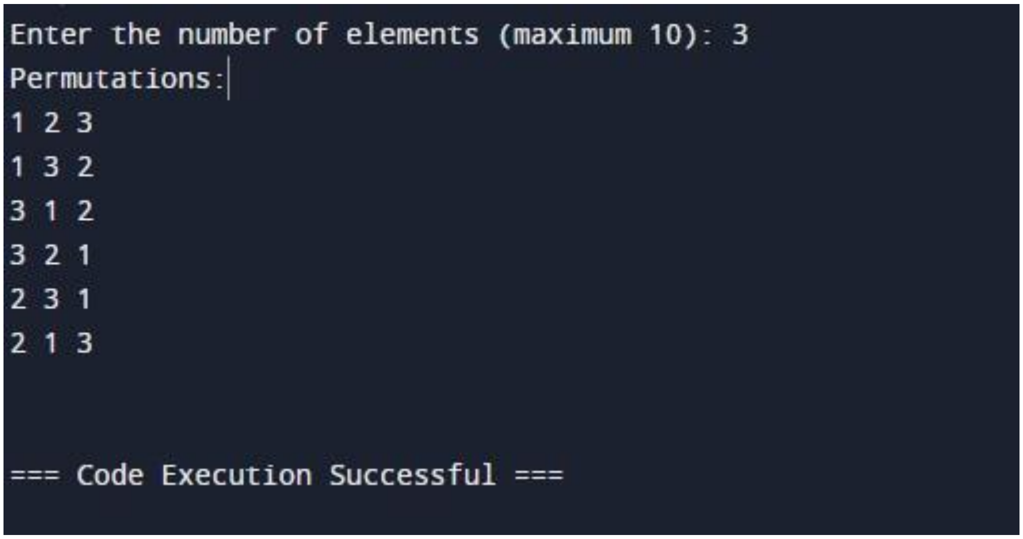
```
Enter number of vertices (maximum 20): 4
Enter adjacency matrix:
0 1 1 1
0 0 0 1
0 0 0 0
0 0 1 0
Topological Order:
0   1   3   2


=== Code Execution Successful ===
```

WEEK 05

Implementation of Johnson Trotter algorithm to generate permutations.

```
#include <stdio.h>
#include <stdbool.h>
#define MAXN 10
// Direction array, dir[i] stores the direction of ith element in permutation
int dir[MAXN];
int n; // Number of elements in the permutation
// Function to print the current permutation
void printPermutation(int perm[]) {
    for (int i = 0; i < n; i++)
        printf("%d ", perm[i]);
    printf("\n");
}
// Function to swap two integers
void swap(int *a, int *b) {
    int temp = *a;
    *a = *b;
    *b = temp;}
// Function to generate all permutations using Johnson-Trotter algorithm
void generatePermutations() {
    int perm[MAXN]; // Current permutation
    for (int i = 0; i < n; i++) {
        perm[i] = i + 1; // Initialize permutation to 1, 2, ..., n
        dir[i] = -1; // All directions initially set to -1 (left)
    }
printPermutation(perm); // Print the initial permutation
 int k, mobile, pos;
    bool found;
while (true) {
        // Step 1: Find the largest mobile integer
        mobile = -1;
        for (int i = 0; i < n; i++) {
            if ((dir[i] == -1 && i != 0 && perm[i] > perm[i - 1]) ||
                (dir[i] == 1 && i != n - 1 && perm[i] > perm[i + 1])) {
                if (mobile == -1 || perm[i] > perm[mobile]) {
                    mobile = i;}}}
        if (mobile == -1) // No more mobile integers, algorithm terminates
            break;
      // Step 2: Swap the mobile integer with the adjacent integer it is pointing to
        k = mobile + dir[mobile];
        swap(&perm[mobile], &perm[k]);
        swap(&dir[mobile], &dir[k]);

        // Step 3: Reverse the direction of all integers greater than the mobile integer
        for (int i = 0; i < n; i++) {
            if (perm[i] > perm[k]) {
                dir[i] = -dir[i];}}
 // Print the current permutation
        printPermutation(perm);}}
int main() {
    printf("Enter the number of elements (maximum %d): ", MAXN);
    scanf("%d", &n);
    if (n <= 0 || n > MAXN) {
        printf("Invalid input. Number of elements should be between 1 and %d.\n", MAXN);
        return 1;
    } generatePermutations(); // Generate permutations using Johnson-Trotter algorithm
return 0;}
```

OUTPUT:



```
Enter the number of elements (maximum 10): 3
Permutations:
1 2 3
1 3 2
3 1 2
3 2 1
2 3 1
2 1 3


=== Code Execution Successful ===
```

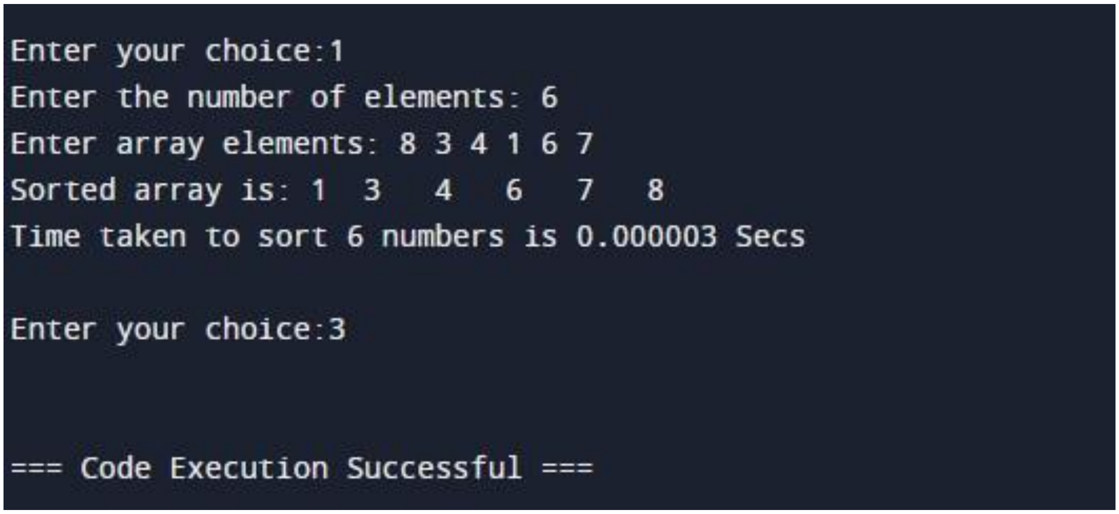
WEEK 06

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.

```
#include<stdio.h>
#include<time.h>
#include<stdlib.h> /* To recognise exit function when compiling with gcc*/
void split(int[],int,int);
void combine(int[],int,int,int);
void main()
{
  int a[15000],n, i,j,ch, temp;
  clock_t start,end;
  while(1)
  {
 printf("\n1:For manual entry of N value and array elements");
 printf("\n2:To display time taken for sorting number of elements N in the range 500 to 14500");
 printf("\n3:To exit");
    printf("\nEnter your choice:");
    scanf("%d", &ch);
    switch(ch)
    {
      case 1:  printf("\nEnter the number of elements: ");
                      scanf("%d",&n);
                      printf("\nEnter array elements: ");
                      for(i=0;i<n;i++)
                       {
                        scanf("%d",&a[i]);
                       }start=clock();
                      split(a,0,n-1);
```

```
                end=clock();
                printf("\nSorted array is: ");
                for(i=0;i<n;i++)
                printf("%d\t",a[i]);
printf("\n Time taken to sort %d numbers is %f Secs",n, (((double)(end-start))/CLOCKS_PER_SEC));
                break;
 case 2:
             n=500;
             while(n<=14500) {
             for(i=0;i<n;i++)
                  {
                   //a[i]=random(1000);
                   a[i]=n-i; }
             start=clock();
             split(a,0,n-1);
        //Dummy loop to create delay
           for(j=0;j<500000;j++){ temp=38/600;}
             end=clock();
printf("\n Time taken to sort %d numbers is %f Secs",n, (((double)(end-start))/CLOCKS_PER_SEC));
                 n=n+1000;}
            break;
  case 3: exit(0); }
  getchar();}}
void split(int a[],int low,int high){
 int mid;
 if(low<high) {
  mid=(low+high)/2;
  split(a,low,mid);
  split(a,mid+1,high);
  combine(a,low,mid,high);}}
void combine(int a[],int low,int mid,int high){
 int c[15000],i,j,k;
 i=k=low;
 j=mid+1;
 while(i<=mid&&j<=high){
  if(a[i]<a[j]) {
   c[k]=a[i];
   ++k;
   ++i; }
  else{
   c[k]=a[j];
   ++k;
   ++j; }}
 if(i>mid)
 {while(j<=high)
  {c[k]=a[j];
   ++k;
   ++j; }}
 if(j>high)
 { while(i<=mid) {
   c[k]=a[i];
   ++k;
   ++i; }}
 for(i=low;i<=high;i++)
 {
  a[i]=c[i];
 }
```

OUTPUT:



```
Enter your choice:1
Enter the number of elements: 6
Enter array elements: 8 3 4 1 6 7
Sorted array is: 1  3   4   6   7   8
Time taken to sort 6 numbers is 0.000003 Secs

Enter your choice:3


=== Code Execution Successful ===
```

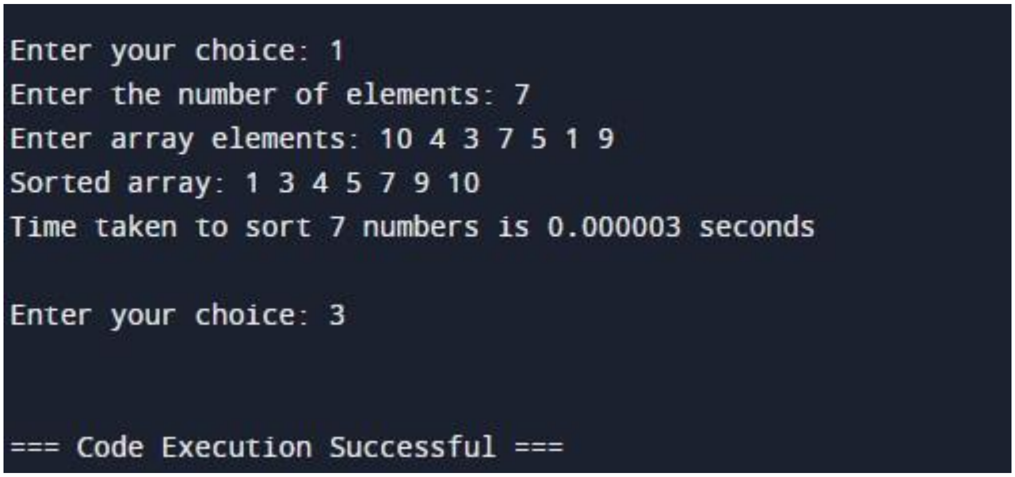
WEEK 07

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

```
#include <stdio.h>
#include <time.h>
#include <stdlib.h>
int a[20];
void quicksort(int [],int ,int);
int partition(int [],int ,int);
void swap(int *,int *);
void main()
{
   int a[15000],n, i,j,ch, temp;
   clock_t start,end;
    int low,high;
   while(1)
   {
 printf("\n1:For manual entry of N value and array elements");
 printf("\n2:To display time taken for sorting number of elements N in the range 500 to 14500");
 printf("\n3:To exit");
     printf("\nEnter your choice:");
     scanf("%d", &ch);
     switch(ch)
     {
       case 1:  printf("\nEnter the number of elements: ");
                    scanf("%d",&n);
                    printf("\nEnter array elements: ");
                    for(i=0;i<n;i++)
                     {
                      scanf("%d",&a[i]);
                     }
                    low=0;
                    high=n-1;
                    start=clock();
                    quicksort(a,low,high);
                    end=clock();
                    printf("\nSorted array is: ");
                    for(i=0;i<n;i++)
          printf("%d\t",a[i]);
printf("\n Time taken to sort %d numbers is %f Secs",n, (((double)(end-
start))/CLOCKS_PER_SEC));
                    break;
    case 2:
                n=500;
                while(n<=14500) {
                for(i=0;i<n;i++)
                      {
          //a[i]=random(1000);
                       a[i]=n-i;
                      }
                start=clock();

                quicksort(a,0,n-1);
         //Dummy loop to create delay
            for(j=0;j<500000;j++){ temp=38/600;}
                end=clock();
printf("\n Time taken to sort %d numbers is %f Secs",n, (((double)(end-
start))/CLOCKS_PER_SEC));
                     n=n+1000;
                      }break;
```

```
   case 3: exit(0);
   }
   getchar();
    }
}
void quicksort(int a[],int low,int high)
{
    int split;
    if(low<high)
    {
        split=partition(a,low,high);
        quicksort(a,low,split-1);
        quicksort(a,split+1,high);
    }
}
 int partition(int a[],int low,int high)
 {
     int pivot=a[low];
     int i=low,j=high+1;
     printf("%d",i);
     do{
 do
        {
             i++;
        }while(a[i]<pivot);
        do
          {
              j--;
          }while(a[j]>pivot);
        swap(&a[i],&a[j]);
     }while(i<j);
     swap(&a[i],&a[j]);
     swap(&a[j],&a[low]);
     return j;
 }
void swap(int *a,int *b)
 { int temp;
     temp=*a;
     *a=*b;
     *b=temp; }
```

OUTPUT:



```
Enter your choice: 1
Enter the number of elements: 7
Enter array elements: 10 4 3 7 5 1 9
Sorted array: 1 3 4 5 7 9 10
Time taken to sort 7 numbers is 0.000003 seconds

Enter your choice: 3


=== Code Execution Successful ===
```

WEEK O8

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

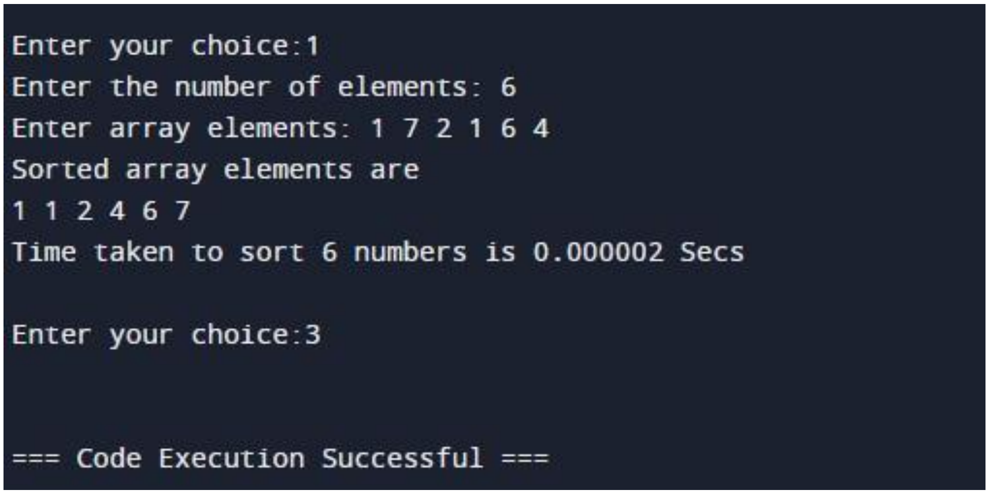
```
#include<stdio.h>
#include<time.h>
#include<stdlib.h>
void heapsort(int n, int a[]);
void heapify(int n, int a[]);
void swap(int* a, int* b);
void main()
{int a[15000], n, i, j, ch, temp;
    clock_t start, end;
 while (1)
    {
        printf("\n 1:For sorting of array elements");
        printf("\n 2:To display time taken for sorting number of elements N in the range 500 to 14500");
        printf("\n 3:To exit");
        printf("\nEnter your choice:");
        scanf("%d", &ch);
 switch (ch)
        {
        case 1:
            printf("\nEnter the number of elements: ");
            scanf("%d", &n);
            printf("\nEnter array elements: ");
            for (i = 0; i < n; i++)
            {
```

```
 scanf("%d", &a[i]);

            }

            start = clock();

            heapsort(n, a);

            end = clock();

             printf("Sorted array elements are\n");

    for (i = 0; i < n; i++)

    {

        printf("%d ", a[i]);

    }

    printf("\n");

            printf("\nTime taken to sort %d numbers is %f Secs\n", n, (((double)(end - start)) /
CLOCKS_PER_SEC));

            break;  case 2:

                  n=500;

      while(n<=14500) {

      for(i=0;i<n;i++)

 {

   //a[i]=random(1000);

   a[i]=n-i;

 }start=clock();

      heapsort(n,a);

          //Dummy loop to create delay

    for(j=0;j<500000;j++){ temp=38/600;}

              end=clock();

         printf("\n Time taken to sort %d numbers is %f Secs",n, (((double)(end-
start))/CLOCKS_PER_SEC));

            n=n+1000; }
```

```
break;
case 3:
            exit(0);}
getchar(); // Consume newline character left in input buffer
    }
}
void heapify(int n, int a[])
{
    int i, p, c, item;
    for (p = (n - 1) / 2; p >= 0; p--)
    {
        item = a[p];
        c = 2 * p + 1;
        while (c < n)
        {
            if (c + 1 < n && a[c] < a[c + 1])
            {
                c++;
            }
            if (item >= a[c])
                break;
            a[p] = a[c];
            p = c;
            c = 2 * p + 1;
        }
        a[p] = item;
    }
```

```
}
void swap(int* a, int* b)
{
    int temp;
    temp = *a;
    *a = *b;
    *b = temp;
}
void heapsort(int n, int a[])
{
    int i;
    heapify(n, a);
    for (i = n - 1; i > 0; i--)
    {
        swap(&a[0], &a[i]);
        heapify(i, a);
    }
}
```

OUTPUT:



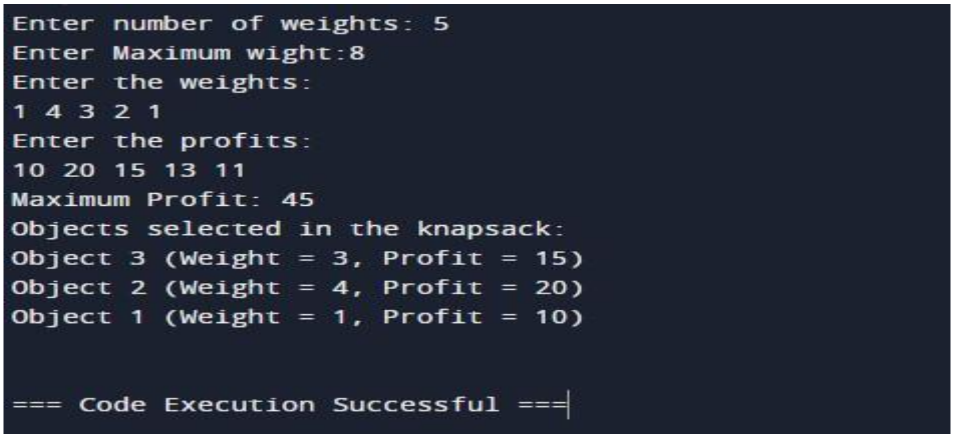
```
Enter your choice:1
Enter the number of elements: 6
Enter array elements: 1 7 2 1 6 4
Sorted array elements are
1 1 2 4 6 7
Time taken to sort 6 numbers is 0.000002 Secs

Enter your choice:3


=== Code Execution Successful ===
```

WEEK 09

Implement 0/1 Knapsack problem using dynamic programming.

```
#include <stdio.h>
#define N 4
int max(int a, int b) {
    return (a > b) ? a : b;
}
void knapsack(int W, int weights[], int profits[]) {
    int dp[N + 1][W + 1];
    for (int i = 0; i <= N; i++) {
        for (int w = 0; w <= W; w++) {
            if (i == 0 || w == 0)
                dp[i][w] = 0;
            else if (weights[i - 1] <= w)
                dp[i][w] = max(profits[i - 1] + dp[i - 1][w - weights[i - 1]], dp[i - 1][w]);
            else
                dp[i][w] = dp[i - 1][w];
        }
    }
    int maxProfit = dp[N][W];
    printf("Maximum Profit: %d\n", maxProfit);
    int w = W;
    printf("Objects selected in the knapsack:\n");
    for (int i = N; i > 0 && maxProfit > 0; i--) {
        if (maxProfit == dp[i - 1][w])
            continue;
        else {
            printf("Object %d (Weight = %d, Profit = %d)\n", i, weights[i - 1], profits[i - 1]);
            maxProfit -= profits[i - 1];
            w -= weights[i - 1];
        }
    }
}
int main() {
    int weights[20],n;
    int profits[20];
    printf("Enter number of weights: ");
    scanf("%d", &n);
    int W = 50;
    printf("Enter the weights:\n")
    for (int j = 0; j < n; j++) {
            scanf("%d", weights[i]);
        }
    printf("Enter the profits:\n");
    for (int j = 0; j < n; j++) {
            scanf("%d", profits[i]);
        }
    knapsack(W, weights, profits);
    return 0;
}
```

OUTPUT:



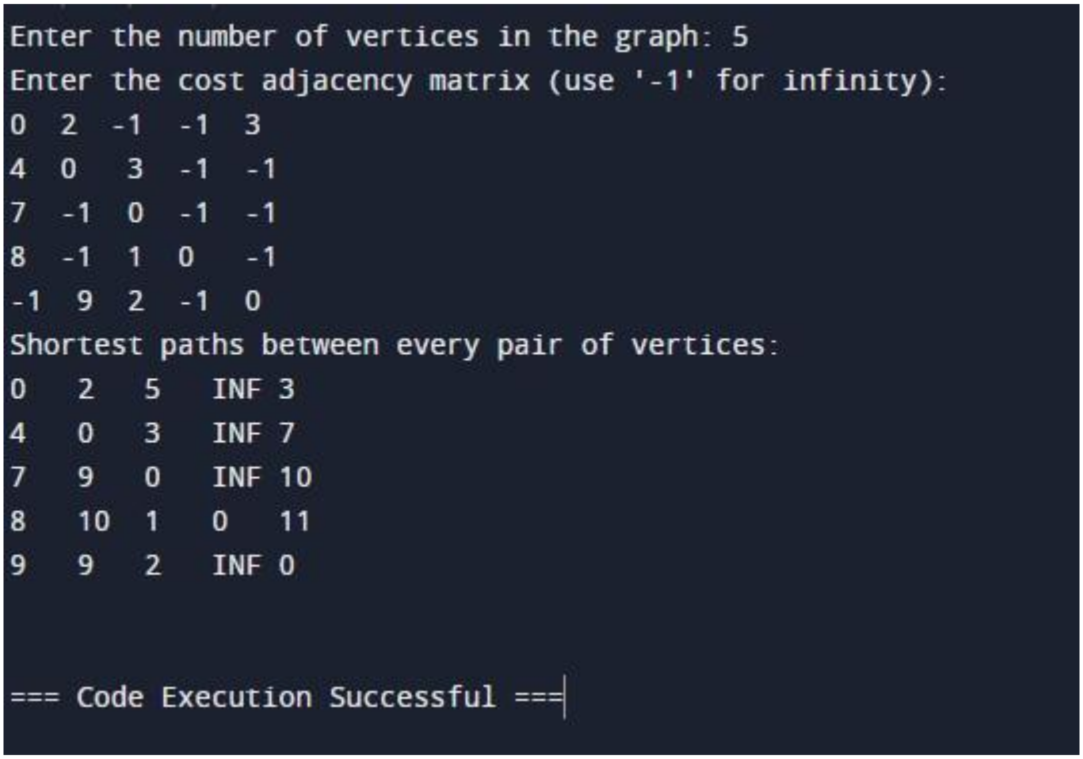
```
Enter number of weights: 5
Enter Maximum wight:8
Enter the weights:
1 4 3 2 1
Enter the profits:
10 20 15 13 11
Maximum Profit: 45
Objects selected in the knapsack:
Object 3 (Weight = 3, Profit = 15)
Object 2 (Weight = 4, Profit = 20)
Object 1 (Weight = 1, Profit = 10)


=== Code Execution Successful ===
```

WEEK 10

Implement All Pair Shortest paths problem using Floyd’s algorithm

```
#include <stdio.h>
#include <limits.h>
void floyd(int n, int cost[][n], int D[][n]) {
    int i, j, k;
    for (i = 0; i < n; i++) {
        for (j = 0; j < n; j++) {
            D[i][j] = cost[i][j];
        }
    }
for (k = 0; k < n; k++) {
        for (i = 0; i < n; i++) {
            for (j = 0; j < n; j++) {
                if (D[i][k] != INT_MAX && D[k][j] != INT_MAX && D[i][j] > D[i][k] + D[k][j]) {
                    D[i][j] = D[i][k] + D[k][j];
                }
            }
        }
    }
}
void printShortestPaths(int n, int D[][n]) {
    printf("Shortest paths between every pair of vertices:\n");
    for (int i = 0; i < n; i++) {
        for (int j = 0; j < n; j++) {
            if (D[i][j] == INT_MAX) {
                printf("INF\t");
            } else {
                printf("%d\t", D[i][j]);
            }
        }
        printf("\n");
    }
}
int main() {
    int n;
    printf("Enter the number of vertices in the graph: ");
    scanf("%d", &n);

    int cost[n][n];
    printf("Enter the cost adjacency matrix (use 'INF' for infinity):\n");
    for (int i = 0; i < n; i++) {
        for (int j = 0; j < n; j++) {
            scanf("%d", &cost[i][j]);
            if (cost[i][j] == -1) {
                cost[i][j] = INT_MAX;
            }
        }
    }
    int D[n][n];
    floyd(n, cost, D); printShortestPaths(n, D);
return 0;}
```

OUTPUT:



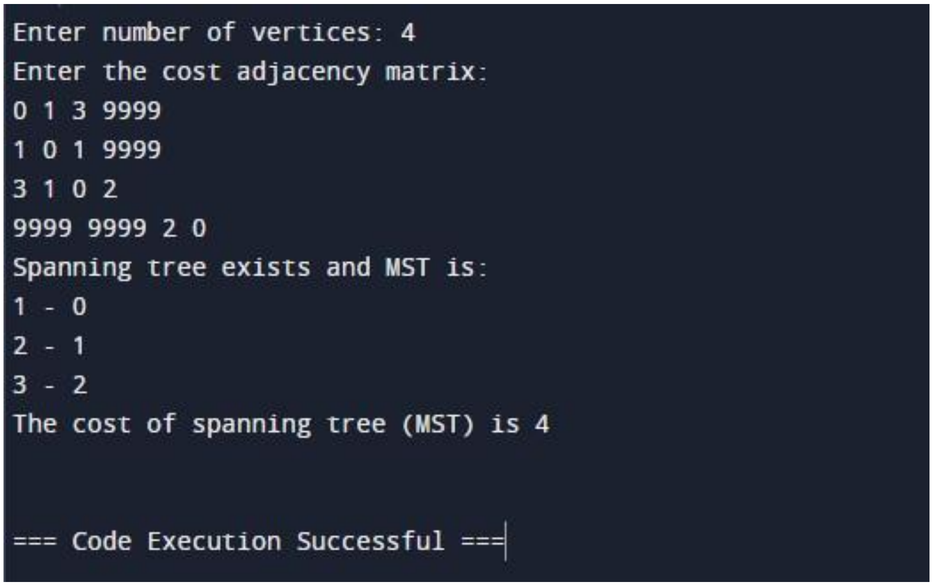
```
Enter the number of vertices in the graph: 5
Enter the cost adjacency matrix (use '-1' for infinity):
0  2  -1  -1  3
4  0   3  -1  -1
7  -1  0  -1  -1
8  -1  1  0   -1
-1  9  2  -1  0
Shortest paths between every pair of vertices:
0   2   5   INF 3
4   0   3   INF 7
7   9   0   INF 10
8   10  1   0   11
9   9   2   INF 0


=== Code Execution Successful ===
```

WEEK 11

- **Find Minimum Cost Spanning Tree of a given undirected graph using Prim’s algorithm.**

```
#include <stdio.h>
#define MAX 9999
void prims(int n, int cost[n][n]) {
    int i, j, u, min, sum = 0, source, K = 0;
    int S[n], d[n], P[n], T[n-1][2];
    min = MAX;
    source = 0;
    for (i = 0; i < n; i++) {
        for (j = 0; j < n; j++) {
            if (cost[i][j] != 0 && cost[i][j] < min) {
                min = cost[i][j];
                source = i;
            }
        }
    }
    for (i = 0; i < n; i++) {
        S[i] = 0;
        d[i] = cost[source][i];
        P[i] = source;
    }
    S[source] = 1;
    for (i = 1; i < n; i++) {
        min = MAX;
        u = -1;
        for (j = 0; j < n; j++) {
            if (S[j] == 0 && d[j] <= min) {
                min = d[j];
                u = j;
            }
        }
        T[K][0] = u;
        T[K][1] = P[u];
        K++;
        sum += cost[u][P[u]];
        S[u] = 1;
        for (j = 0; j < n; j++) {
            if (S[j] == 0 && cost[u][j] < d[j]) {
                d[j] = cost[u][j];
                P[j] = u;
            }
        }
    }
    if (sum >= MAX) {
        printf("Spanning tree does not exist.\n");
    } else {
        printf("Spanning tree exists and MST is:\n");
        for (i = 0; i < n-1; i++) {
            printf("%d - %d\n", T[i][0], T[i][1]);
        }
        printf("The cost of spanning tree (MST) is %d\n", sum);
    }
}
int main() {
    int n;
    printf("Enter number of vertices: ");
    scanf("%d", &n);
    int cost[n][n];
    printf("Enter the cost adjacency matrix:\n");
    for (int i = 0; i < n; i++) {
        for (int j = 0; j < n; j++) {
            scanf("%d", &cost[i][j]);
        }
    }
prims(n, cost);
return 0;
}
```

OUTPUT:

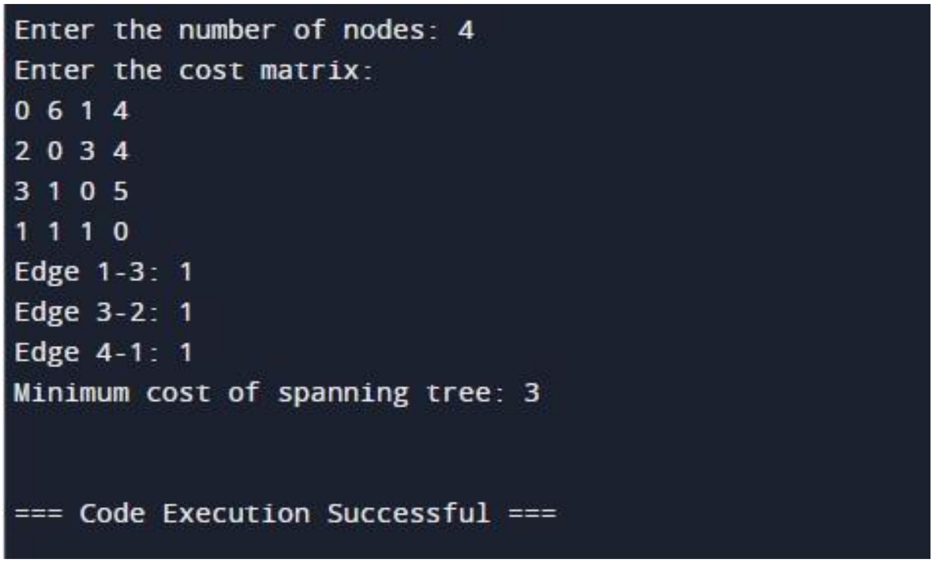


```
Enter number of vertices: 4
Enter the cost adjacency matrix:
0 1 3 9999
1 0 1 9999
3 1 0 2
9999 9999 2 0
Spanning tree exists and MST is:
1 - 0
2 - 1
3 - 2
The cost of spanning tree (MST) is 4


=== Code Execution Successful ===
```

- **Find Minimum Cost Spanning Tree of a given undirected graph using Kruskal’s algorithm.**

```
#include <stdio.h>
#define MAX 9999 // Infinity value assumed
void kruskals(int c[][100], int n);
int main() {
    int n, i, j;
    int c[100][100]; // Assuming a maximum size for the cost matrix
     printf("Enter the number of nodes: ");
    scanf("%d", &n);
     printf("Enter the cost matrix:\n");
    for (i = 1; i <= n; i++) {
        for (j = 1; j <= n; j++) {
            scanf("%d", &c[i][j]);
            if (c[i][j] == 0) // Assuming 0 represents no edge, set it to a large value
                c[i][j] = MAX;
        }
    } kruskals(c, n);
return 0;}
void kruskals(int c[][100], int n) {
    int ne = 0, mincost = 0;
    int parent[100];
    int min, u, v, a, b, i, j;
for (i = 1; i <= n; i++)
        parent[i] = 0;
while (ne != n - 1) {
        min = MAX;
for (i = 1; i <= n; i++) {
            for (j = 1; j <= n; j++) {
                if (c[i][j] < min) {
                    min = c[i][j];
                    u = a = i;
                    v = b = j;}}}
        while (parent[u] != 0)
            u = parent[u];
     while (parent[v] != 0)
            v = parent[v];
     if (u != v) {
            printf("Edge %d-%d: %d\n", a, b, min);
            parent[v] = u;
            mincost += min;
            ne++;
        }c[a][b] = c[b][a] = MAX;
    } printf("Minimum cost of spanning tree: %d\n", mincost);
}
```

OUTPUT:



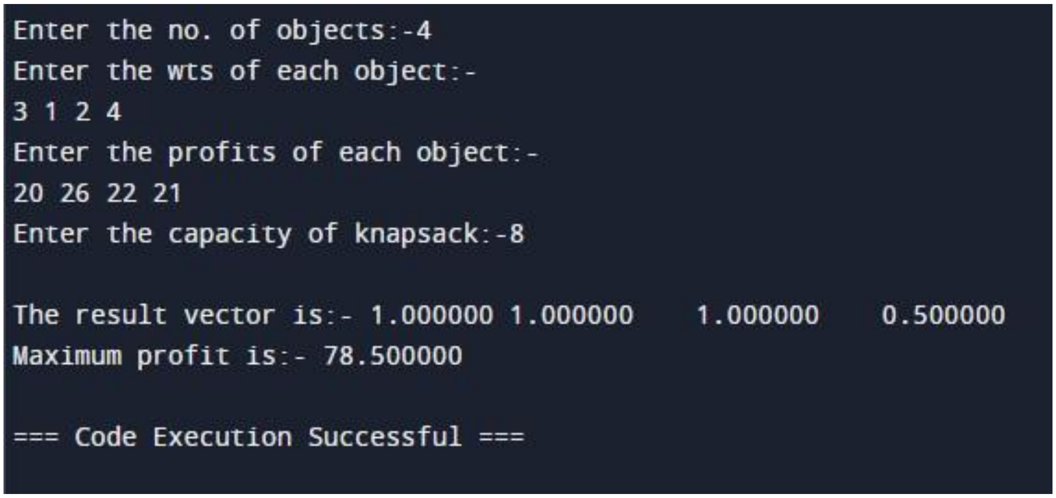
```
Enter the number of nodes: 4
Enter the cost matrix:
0 6 1 4
2 0 3 4
3 1 0 5
1 1 1 0
Edge 1-3: 1
Edge 3-2: 1
Edge 4-1: 1
Minimum cost of spanning tree: 3


=== Code Execution Successful ===
```

WEEK 12

Implement Fractional Knapsack using Greedy technique.

```
#include<stdio.h>
void knapsack(int n, float weight[], float profit[], float capacity)
{
   float x[20], tp = 0;
   int i, j, u;
   u = capacity;
   for (i = 0; i < n; i++)
      x[i] = 0.0;
   for (i = 0; i < n; i++) {
      if (weight[i] > u)
  break;
      else {
         x[i] = 1.0;
         tp = tp + profit[i];
         u = u - weight[i];
      }}
   if (i < n)
      x[i] = u / weight[i];
   tp = tp + (x[i] * profit[i]);
   printf("\nThe result vector is:- ");
   for (i = 0; i < n; i++)
      printf("%f\t", x[i]);
   printf("\nMaximum profit is:- %f", tp);
}
int main() {
   float weight[20], profit[20], capacity;
   int num, i, j;
   float ratio[20], temp;
   printf("\nEnter the no. of objects:- ");
   scanf("%d", &num);
   printf("\nEnter the wts and profits of each object:- ");
   for (i = 0; i < num; i++) {
      scanf("%f %f", &weight[i], &profit[i]);
   }
   printf("\nEnter the capacity of knapsack:- ");
   scanf("%f", &capacity);
   for (i = 0; i < num; i++) {
      ratio[i] = profit[i] / weight[i];
   }
for (i = 0; i < num; i++) {
      for (j = i + 1; j < num; j++) {
         if (ratio[i] < ratio[j]) {
           temp = ratio[j];
           ratio[j] = ratio[i];
           ratio[i] = temp;
           temp = weight[j];
           weight[j] = weight[i];
           weight[i] = temp;
           temp = profit[j];
           profit[j] = profit[i];
           profit[i] = temp;
         }
      }
   }
   knapsack(num, weight, profit, capacity);
   return(0);
}
```

OUTPUT:



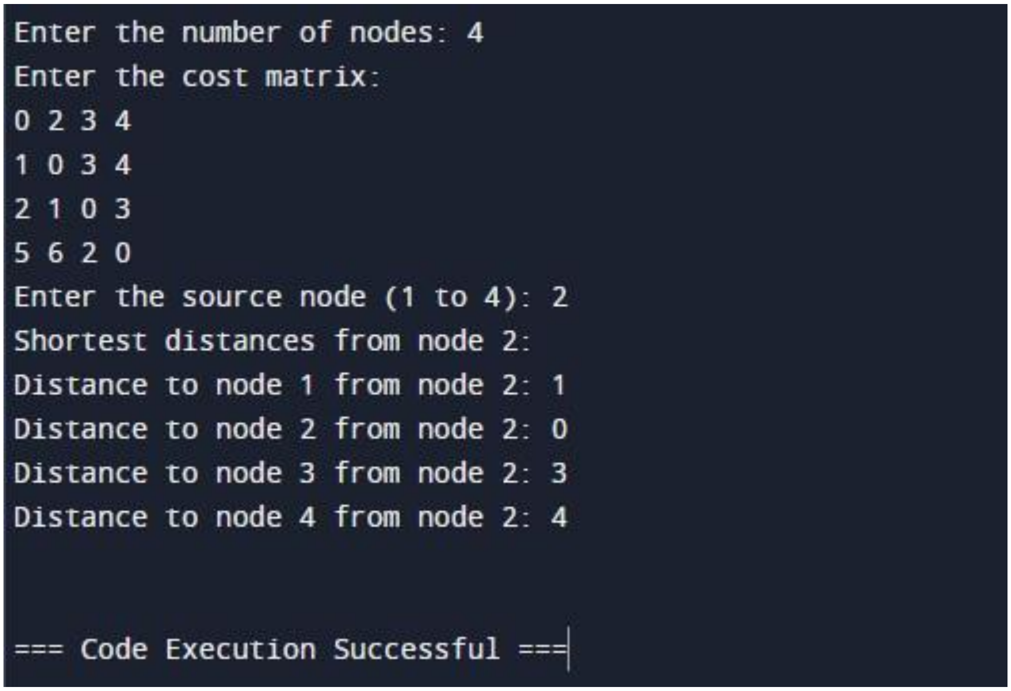
```
Enter the no. of objects:-4
Enter the wts of each object:-
3 1 2 4
Enter the profits of each object:-
20 26 22 21
Enter the capacity of knapsack:-8

The result vector is:- 1.000000 1.000000    1.000000    0.500000
Maximum profit is:- 78.500000

=== Code Execution Successful ===
```

WEEK 13

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

```
#include <stdio.h>
#define MAX 9999 // Infinity value assumed
void dijkstras(int c[][100], int n, int src);
int main() {
    int n, src, i, j;
    int c[100][100]; // Assuming a maximum size for the cost matrix
    printf("Enter the number of nodes: ");
    scanf("%d", &n);
    printf("Enter the cost matrix:\n");
    for (i = 1; i <= n; i++) {
        for (j = 1; j <= n; j++) {
            scanf("%d", &c[i][j]);
        }
    }
    printf("Enter the source node (1 to %d): ", n);
    scanf("%d", &src);
    dijkstras(c, n, src);
    return 0;
}
void dijkstras(int c[][100], int n, int src) {
    int dist[100], vis[100];
    int count, min, u, i, j;
    // Initialization
    for (j = 1; j <= n; j++) {
        dist[j] = c[src][j];
        vis[j] = 0;
    }
    dist[src] = 0;
    vis[src] = 1;
    count = 1;
    // Main loop
    while (count != n) {
        min = MAX;
        // Find the minimum distance vertex from the set of vertices not yet processed
        for (j = 1; j <= n; j++) {
            if (dist[j] < min && vis[j] != 1) {
                min = dist[j];
                u = j;
            }
        }
        vis[u] = 1;
        count++;
        // Update dist value of the adjacent vertices of the picked vertex
        for (j = 1; j <= n; j++) {
            if (min + c[u][j] < dist[j] && vis[j] != 1) {
                dist[j] = min + c[u][j];
            }
        }
    }
    // Output shortest distances
    printf("Shortest distances from node %d:\n", src);
    for (j = 1; j <= n; j++) {
        printf("Distance to node %d from node %d: %d\n", j, src, dist[j]);
    }
}
```

OUTPUT:



```
Enter the number of nodes: 4
Enter the cost matrix:
0 2 3 4
1 0 3 4
2 1 0 3
5 6 2 0
Enter the source node (1 to 4): 2
Shortest distances from node 2:
Distance to node 1 from node 2: 1
Distance to node 2 from node 2: 0
Distance to node 3 from node 2: 3
Distance to node 4 from node 2: 4


=== Code Execution Successful ===
```

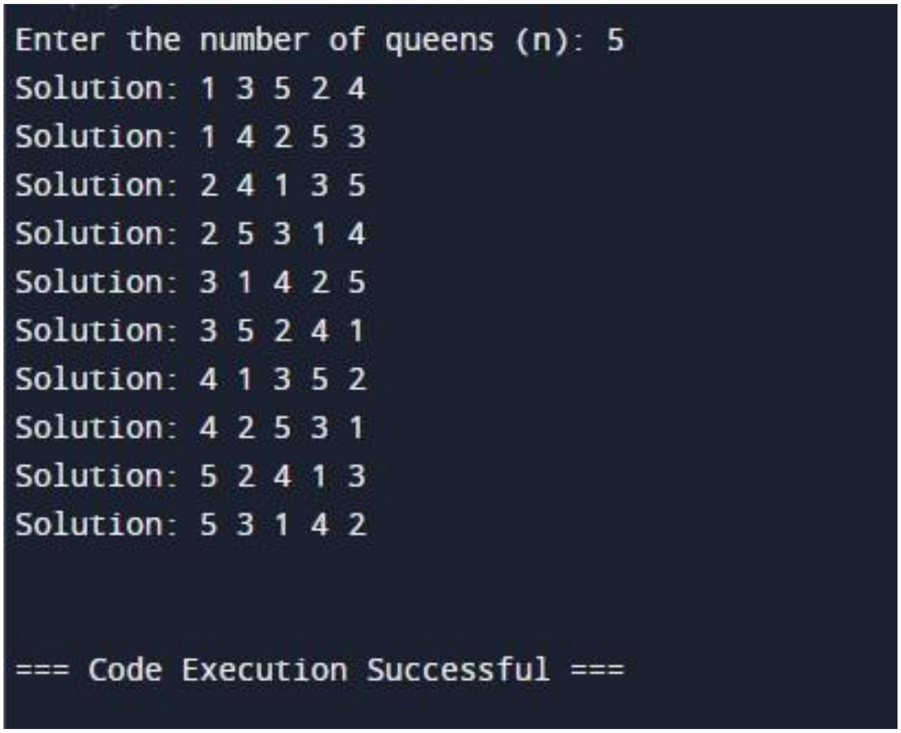
WEEK 14

Implement “N-Queens Problem” using Backtracking.

```
#include<stdio.h>
#define BOARD_SIZE 5
void displayChess(int chBoard[BOARD_SIZE][BOARD_SIZE]) {
  for (int row = 0; row < BOARD_SIZE; row++) {
    for (int col = 0; col < BOARD_SIZE; col++)
      printf("%d ", chBoard[row][col]);
    printf("\n");
  }
}
int isQueenPlaceValid(int chBoard[BOARD_SIZE][BOARD_SIZE], int crntRow, int crntCol) {
  // checking if queen is in the left or not
  for (int i = 0; i < crntCol; i++)
    if (chBoard[crntRow][i])
      return 0;
  for (int i = crntRow, j = crntCol; i >= 0 && j >= 0; i--, j--)
    //checking if queen is in the left upper diagonal or not
    if (chBoard[i][j])
      return 0;
  for (int i = crntRow, j = crntCol; j >= 0 && i < BOARD_SIZE; i++, j--)
    //checking if queen is in the left lower diagonal or not
    if (chBoard[i][j])
      return 0;
  return 1;
}
int solveProblem(int chBoard[BOARD_SIZE][BOARD_SIZE], int crntCol) {
  //when N queens are placed successfully
  if (crntCol >= BOARD_SIZE)
    return 1;
  // checking placement of queen is possible or not
  for (int i = 0; i < BOARD_SIZE; i++) {
    if (isQueenPlaceValid(chBoard, i, crntCol)) {
      //if validate, place the queen at place (i, col)
      chBoard[i][crntCol] = 1;
      //Go for the other columns recursively
      if (solveProblem(chBoard, crntCol + 1))
        return 1;
      //When no place is vacant remove that queen
      chBoard[i][crntCol] = 0;
    }
  }
  return 0;
}
int displaySolution() {
  int chBoard[BOARD_SIZE][BOARD_SIZE];
  for(int i = 0; i < BOARD_SIZE; i++)
    for(int j = 0; j < BOARD_SIZE; j++)
      //set all elements to 0
      chBoard[i][j] = 0;
  //starting from 0th column
  if (solveProblem(chBoard, 0) == 0) {
    printf("Solution does not exist");
    return 0;
  }
  displayChess(chBoard);
  return 1;
}
```

```
int main() {
   displaySolution();
   return 0;
}
```

OUTPUT:



```
Enter the number of queens (n): 5
Solution: 1 3 5 2 4
Solution: 1 4 2 5 3
Solution: 2 4 1 3 5
Solution: 2 5 3 1 4
Solution: 3 1 4 2 5
Solution: 3 5 2 4 1
Solution: 4 1 3 5 2
Solution: 4 2 5 3 1
Solution: 5 2 4 1 3
Solution: 5 3 1 4 2


=== Code Execution Successful ===
```