1.Design and implement C Program to find Minimum Cost Spanning Tree of a given connected undirected graph using Kruskal's algorithm

PROGRAM:

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

#define MAX_EDGES 1000

typedef struct Edge {
    int src, dest, weight;
} Edge;

typedef struct Graph {
    int V, E;
    Edge edges[MAX_EDGES];
} Graph;

typedef struct Subset {
    int parent, rank;
} Subset;

Graph* createGraph(int V, int E) {
    Graph* graph = (Graph*) malloc(sizeof(Graph));
    graph->V = V;
    graph->E = E;
    return graph;
}

int find(Subset subsets[], int i) {
    if (subsets[i].parent != i) {
        subsets[i].parent = find(subsets, subsets[i].parent);
    }
    return subsets[i].parent;
}

void Union(Subset subsets[], int x, int y) {
    int xroot = find(subsets, x);
    int yroot = find(subsets, y);

    if (subsets[xroot].rank < subsets[yroot].rank) {
        subsets[xroot].parent = yroot;
    } else if (subsets[xroot].rank > subsets[yroot].rank) {
        subsets[yroot].parent = xroot;
    } else {
        subsets[yroot].parent = xroot;
        subsets[xroot].rank++;
    }
}

int compare(const void* a, const void* b) {
```

```c
    Edge* a_edge = (Edge*) a;
    Edge* b_edge = (Edge*) b;
    return a_edge->weight - b_edge->weight;
}

void kruskalMST(Graph* graph) {
    Edge mst[graph->V];
    int e = 0, i = 0;

    qsort(graph->edges, graph->E, sizeof(Edge), compare);

    Subset* subsets = (Subset*) malloc(graph->V * sizeof(Subset));
    for (int v = 0; v < graph->V; ++v) {
        subsets[v].parent = v;
        subsets[v].rank = 0;
    }

    while (e < graph->V - 1 && i < graph->E) {
        Edge next_edge = graph->edges[i++];

        int x = find(subsets, next_edge.src);
        int y = find(subsets, next_edge.dest);

        if (x != y) {
            mst[e++] = next_edge;
            Union(subsets, x, y);
        }
    }

    printf("Minimum Spanning Tree:\n");
    for (i = 0; i < e; ++i) {
        printf("(%d, %d) -> %d\n", mst[i].src, mst[i].dest, mst[i].weight);
    }
}

int main() {
    int V, E;
    printf("Enter number of vertices and edges: ");
    scanf("%d %d", &V, &E);

    Graph* graph = createGraph(V, E);

    printf("Enter edges and their weights:\n");
    for (int i = 0; i < E; ++i) {
        scanf("%d %d %d", &graph->edges[i].src, &graph->edges[i].dest, &graph-
>edges[i].weight);
    }

    kruskalMST(graph);

    return 0;
}
```

OUTPUT:

```
student@lenovo-ThinkCentre-M900:~$ gedit 1.c
student@lenovo-ThinkCentre-M900:~$ gcc 1.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter number of vertices and edges: 5 7
Enter edges and their weights:
0 1 2
0 3 6
1 2 3
1 3 8
1 4 5
2 4 7
3 4 9
Minimum Spanning Tree:
(0, 1) -> 2
(1, 2) -> 3
(1, 4) -> 5
(0, 3) -> 6
```

2.Design and implement C Program to find Minimum Cost Spanning Tree of a given connected undirected graph using Prim's algorithm

PROGRAM:

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

#define V_MAX 100 // Maximum number of vertices

// Function to find the vertex with the minimum key value, from the set of vertices not yet included
in the MST
int minKey(int key[], int mstSet[], int V) {
    int min = INT_MAX, min_index;

    for (int v = 0; v < V; v++)
        if (mstSet[v] == 0 && key[v] < min)
            min = key[v], min_index = v;

    return min_index;
}

// Function to print the constructed MST stored in parent[]
void printMST(int parent[], int n, int graph[V_MAX][V_MAX], int V) {
    printf("Edge   Weight\n");
    for (int i = 1; i < V; i++)
        printf("%d - %d    %d \n", parent[i], i, graph[i][parent[i]]);
}

// Function to construct and print MST for a graph represented using adjacency matrix
representation
void primMST(int graph[][V_MAX], int V) {
    int parent[V_MAX]; // Array to store constructed MST
    int key[V_MAX]; // Key values used to pick minimum weight edge in cut
    int mstSet[V_MAX]; // To represent set of vertices not yet included in MST

    // Initialize all keys as INFINITE, mstSet[] as 0
    for (int i = 0; i < V; i++)
        key[i] = INT_MAX, mstSet[i] = 0;

    // Always include first 1st vertex in MST. Make key 0 so that this vertex is picked as the first
vertex
    key[0] = 0;
    parent[0] = -1; // First node is always the root of MST

    // The MST will have V vertices
    for (int count = 0; count < V - 1; count++) {
        // Pick the minimum key vertex from the set of vertices not yet included in MST
        int u = minKey(key, mstSet, V);

        // Add the picked vertex to the MST set
```

```
        mstSet[u] = 1;

        // Update key value and parent index of the adjacent vertices of the picked vertex
        // Consider only those vertices which are not yet included in the MST
        for (int v = 0; v < V; v++)
            if (graph[u][v] && mstSet[v] == 0 && graph[u][v] < key[v])
                parent[v] = u, key[v] = graph[u][v];
    }

    // Print the constructed MST
    printMST(parent, V, graph, V);
}

int main() {
    int V, E;
    printf("Enter the number of vertices and edges: ");
    scanf("%d %d", &V, &E);

    // Create the graph as an adjacency matrix
    int graph[V_MAX][V_MAX];
    for (int i = 0; i < V; i++) {
        for (int j = 0; j < V; j++) {
            graph[i][j] = 0; // Initialize the graph with 0s
        }
    }

    // Prompt the user to enter the source vertex, destination vertex, and weight for each edge
    printf("Enter the source vertex, destination vertex, and weight for each edge:\n");
    for (int i = 0; i < E; i++) {
        int source, dest, weight;
        scanf("%d %d %d", &source, &dest, &weight);
        graph[source][dest] = weight;
        graph[dest][source] = weight; // Since the graph is undirected
    }

    // Print the MST using Prim's algorithm
    primMST(graph, V);

    return 0;
}
```
OUTPUT:

```
student@lenovo-ThinkCentre-M900:~$ gedit 2.c
student@lenovo-ThinkCentre-M900:~$ gcc 2.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of vertices and edges: 5
7
Enter the source vertex, destination vertex, and weight for each edge:
0 1 2
0 3 6
1 2 3
1 3 8
1 4 5
2 4 7
3 4 9
Edge   Weight
0 - 1    2
1 - 2    3
0 - 3    6
1 - 4    5
```

3.a. Design and implement C Program to solve All-Pairs Shortest Paths problem using Floyd's algorithm.

PROGRAM:

```
#include<stdio.h>

int min(int,int);
void floyds(int p[10][10],int n) {
        int i,j,k;
        for (k=1;k<=n;k++)
          for (i=1;i<=n;i++)
           for (j=1;j<=n;j++)
            if(i==j)
             p[i][j]=0; else
             p[i][j]=min(p[i][j],p[i][k]+p[k][j]);
}
int min(int a,int b) {
        if(a<b)
          return(a); else
          return(b);
}
void main() {
        int p[10][10],w,n,e,u,v,i,j;

        printf("\n Enter the number of vertices:");
        scanf("%d",&n);
        printf("\n Enter the number of edges:\n");
        scanf("%d",&e);
        for (i=1;i<=n;i++) {
                    for (j=1;j<=n;j++)
                      p[i][j]=999;
        }
        for (i=1;i<=e;i++) {
                    printf("\n Enter the end vertices of edge%d with its weight \n",i);
                    scanf("%d%d%d",&u,&v,&w);
                    p[u][v]=w;
        }
        printf("\n Matrix of input data:\n");
        for (i=1;i<=n;i++) {
                    for (j=1;j<=n;j++)
                      printf("%d \t",p[i][j]);
                    printf("\n");
        }
        floyds(p,n);
        printf("\n Transitive closure:\n");
        for (i=1;i<=n;i++) {
                    for (j=1;j<=n;j++)
                      printf("%d \t",p[i][j]);
                    printf("\n");
        }
        printf("\n The shortest paths are:\n");
```

```
        for (i=1;i<=n;i++)
          for (j=1;j<=n;j++) {
                if(i!=j)
                    printf("\n <%d,%d>=%d",i,j,p[i][j]);
        }

    }
```

OUTPUT:

```
student@lenovo-ThinkCentre-M900:~$ gcc 3a.c
student@lenovo-ThinkCentre-M900:~$ ./a.out

 Enter the number of vertices:4
Enter the number of edges:5
Enter the end vertices of edge1 with its weight
1 3 3
Enter the end vertices of edge2 with its weight
2 1 2
Enter the end vertices of edge3 with its weight
3 2 7
Enter the end vertices of edge4 with its weight
3 4 1
Enter the end vertices of edge5 with its weight
4 1 6
Matrix of input data:
999     999     3       999
2       999     999     999
999     7       999     1
6       999     999     999
Transitive closure:
0       10      3       4
2       0       5       6
7       7       0       1
6       16      9       0

 The shortest paths are:

 <1,2>=10
 <1,3>=3
 <1,4>=4
 <2,1>=2
 <2,3>=5
 <2,4>=6
 <3,1>=7
 <3,2>=7
 <3,4>=1
 <4,1>=6
 <4,2>=16
```

3b.Design and implement C Program to find the transitive closure using Warshal's algorithm.

PROGRAM:

```
#include<stdio.h>

#include<math.h>

int max(int, int);

void warshal(int p[10][10], int n) {

    int i, j, k;

    for (k = 1; k <= n; k++)

        for (i = 1; i <= n; i++)

            for (j = 1; j <= n; j++)

                p[i][j] = max(p[i][j], p[i][k] && p[k][j]);

}

int max(int a, int b) {

    ;

    if (a > b)

        return (a);

    else

        return (b);

}

void main() {

    int p[10][10] = { 0 }, n, e, u, v, i, j;

    printf("\n Enter the number of vertices:");

    scanf("%d", &n);

    printf("\n Enter the number of edges:");

    scanf("%d", &e);

    for (i = 1; i <= e; i++) {
```

```
            printf("\n Enter the end vertices of edge %d:", i);

            scanf("%d%d", &u, &v);

            p[u][v] = 1;

        }

        printf("\n Matrix of input data: \n");

        for (i = 1; i <= n; i++) {

            for (j = 1; j <= n; j++)

                printf("%d\t", p[i][j]);

            printf("\n");

        }

        warshal(p, n);

        printf("\n Transitive closure: \n");

        for (i = 1; i <= n; i++) {

            for (j = 1; j <= n; j++)

                printf("%d\t", p[i][j]);

            printf("\n");

        }


    }
```

OUTPUT:

```
student@lenovo-ThinkCentre-M900:~$ gedit 3b.c
student@lenovo-ThinkCentre-M900:~$ gcc 3b.c
student@lenovo-ThinkCentre-M900:~$ ./a.out

Enter the number of vertices:5
Enter the number of edges:11

Enter the end vertices of edge 1:1 1
Enter the end vertices of edge 2:1 4
Enter the end vertices of edge 3:3 2
Enter the end vertices of edge 4:3 3
Enter the end vertices of edge 5:3 4
Enter the end vertices of edge 6:4 2
```

Enter the end vertices of edge 7:4 4
Enter the end vertices of edge 8:5 2
Enter the end vertices of edge 9:5 3
Enter the end vertices of edge 10:5 4
Enter the end vertices of edge 11:5 5

Matrix of input data:

1	0	0	1	0
0	0	0	0	0
0	1	1	1	0
0	1	0	1	0
0	1	1	1	1

Transitive closure:

1	1	0	1	0
0	0	0	0	0
0	1	1	1	0
0	1	0	1	0
0	1	1	1	1

4.Design and implement C Program to find shortest paths from a given vertex in a weighted connected graph to other vertices using Dijkstra's algorithm

PROGRAM:

```
  #include <stdio.h>
#include <stdbool.h>
#include <limits.h>

#define MAX_VERTICES 10  // Maximum number of vertices
#define INF INT_MAX

// A function to find the vertex with the minimum distance value, from the set of vertices not yet
included in the shortest path tree
int minDistance(int dist[], bool sptSet[], int V) {
   int min = INF, min_index;

   for (int v = 0; v < V; v++)
      if (sptSet[v] == false && dist[v] <= min)
         min = dist[v], min_index = v;

   return min_index;
}

// A utility function to print the constructed distance array
void printSolution(int dist[], int V) {
   printf("Vertex \t\t Distance from Source\n");
   for (int i = 0; i < V; i++)
      printf("%d \t\t %d\n", i, dist[i]);
}

// Dijkstra's algorithm for adjacency matrix representation of the graph
void dijkstra(int graph[MAX_VERTICES][MAX_VERTICES], int src, int V) {
   int dist[MAX_VERTICES];  // The output array. dist[i] will hold the shortest distance from src to
i
   bool sptSet[MAX_VERTICES];  // sptSet[i] will be true if vertex i is included in the shortest path
tree

   // Initialize all distances as INFINITE and sptSet[] as false
   for (int i = 0; i < V; i++)
      dist[i] = INF, sptSet[i] = false;

   dist[src] = 0;

   // Find shortest path for all vertices
   for (int count = 0; count < V - 1; count++) {
      int u = minDistance(dist, sptSet, V);
      sptSet[u] = true;
      for (int v = 0; v < V; v++)
         if (!sptSet[v] && graph[u][v] && dist[u] != INF && dist[u] + graph[u][v] < dist[v])
            dist[v] = dist[u] + graph[u][v];
   }
```

```
    printSolution(dist, V);
}

// Driver code
int main() {
    int V, E;
    printf("Enter the number of vertices: ");
    scanf("%d", &V);
    printf("Enter the number of edges: ");
    scanf("%d", &E);

    int graph[MAX_VERTICES][MAX_VERTICES] = {{0}};

    printf("Enter the source vertex, destination vertex, and weight for each edge:\n");
    for (int i = 0; i < E; i++) {
        int source, dest, weight;
        scanf("%d %d %d", &source, &dest, &weight);
        graph[source][dest] = weight;
        graph[dest][source] = weight; // Assuming undirected graph
    }

    dijkstra(graph, 0, V);
    return 0;
}
```

OUTPUT:

```
student@lenovo-ThinkCentre-M900:~$ gedit 4.c
student@lenovo-ThinkCentre-M900:~$ gcc 4.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of vertices: 5
Enter the number of edges: 7
Enter the source vertex, destination vertex, and weight for each edge:
0 1 2
0 3 6
1 2 3
1 3 8
1 4 5
2 4 7
3 4 9
Vertex           Distance from Source
0                0
1                2
2                5
3                6
4                7
```

5.Design and implement C Program to obtain the Topological ordering of vertices in a given digraph.

PROGRAM:

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

#define MAX_VERTICES 100

// Structure to represent a graph
typedef struct {
   int V;
   int** adjMatrix;
} Graph;

// Function to create a new graph
Graph* createGraph(int V) {
   Graph* graph = (Graph*)malloc(sizeof(Graph));
   graph->V = V;
   graph->adjMatrix = (int**)calloc(V, sizeof(int*));
   for (int i = 0; i < V; i++) graph->adjMatrix[i] = (int*)calloc(V, sizeof(int));
   return graph;
}

// Function to add an edge to the graph
void addEdge(Graph* graph, int src, int dest) {
   graph->adjMatrix[src][dest] = 1;
}

// Function to perform topological sorting
void topologicalSort(Graph* graph) {
   int V = graph->V, inDegree[MAX_VERTICES] = {0}, queue[MAX_VERTICES], front = 0, rear
= -1;

   for (int i = 0; i < V; i++)
      for (int j = 0; j < V; j++)
         if (graph->adjMatrix[i][j] == 1) inDegree[j]++;

   for (int i = 0; i < V; i++) if (inDegree[i] == 0) queue[++rear] = i;

   printf("Topological ordering of vertices: ");
   while (front <= rear) {
      int vertex = queue[front++];
      printf("%d ", vertex);
      for (int i = 0; i < V; i++) if (graph->adjMatrix[vertex][i] == 1 && --inDegree[i] == 0)
queue[++rear] = i;
   }
   printf("\n");
}

// Driver code
```

```
int main() {
    int V, E;
    printf("Enter the number of vertices: ");
    scanf("%d", &V);
    Graph* graph = createGraph(V);
    printf("Enter the number of edges: ");
    scanf("%d", &E);
    printf("Enter the edges (source vertex, destination vertex):\n");
    for (int i = 0, src, dest; i < E; i++) {
        scanf("%d %d", &src, &dest);
        addEdge(graph, src, dest);
    }
    topologicalSort(graph);
    return 0;
}
```

OUTPUT:

```
student@lenovo-ThinkCentre-M900:~$ gcc 5.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of vertices: 7
Enter the number of edges: 8
Enter the edges (source vertex, destination vertex):
0 1
0 2
1 3
2 3
3 4
3 5
4 6
5 6
Topological ordering of vertices: 0 1 2 3 4 5 6
```

6.Design and implement C Program to solve 0/1 Knapsack problem using Dynamic Programming method.

PROGRAM:

```
#include <stdio.h>

// Function to find maximum of two integers
int max(int a, int b) {
    return (a > b) ? a : b;
}

// Function to solve 0/1 Knapsack problem
int knapsack(int W, int wt[], int val[], int n) {
    int i, w;
    int K[n + 1][W + 1];

    // Build table K[][] in bottom-up manner
    for (i = 0; i <= n; i++) {
        for (w = 0; w <= W; w++) {
            if (i == 0 || w == 0)
                K[i][w] = 0;
            else if (wt[i - 1] <= w)
                K[i][w] = max(val[i - 1] + K[i - 1][w - wt[i - 1]], K[i - 1][w]);
            else
                K[i][w] = K[i - 1][w];
        }
    }

    // K[n][W] contains the maximum value that can be put in a knapsack of capacity W
    return K[n][W];
}

int main() {
    int val[100], wt[100]; // Arrays to store values and weights
    int W, n; // Knapsack capacity and number of items
    printf("Enter the number of items: ");
    scanf("%d", &n);

    printf("Enter the values and weights of %d items:\n", n);
    for (int i = 0; i < n; i++) {
        printf("Enter value and weight for item %d: ", i + 1);
        scanf("%d %d", &val[i], &wt[i]);
    }

    printf("Enter the knapsack capacity: ");
    scanf("%d", &W);

    printf("Maximum value that can be obtained: %d\n", knapsack(W, wt, val, n));

    return 0;
}
```

OUTPUT:

```
student@lenovo-ThinkCentre-M900:~$ gcc 6.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of items: 4
Enter the values and weights of 4 items:
Enter value and weight for item 1: 42 7
Enter value and weight for item 2: 12 3
Enter value and weight for item 3: 40 4
Enter value and weight for item 4: 25 5
Enter the knapsack capacity: 10
Maximum value that can be obtained: 65
```

7.Design and implement C Program to solve discrete Knapsack and continuous Knapsack problems using greedy approximation method.

PROGRAM:

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

// Structure to represent items
struct Item {
    int value;
    int weight;
    double ratio; // Value-to-weight ratio for sorting
};

// Comparison function for sorting items based on ratio in descending order
int compare(const void *a, const void *b) {
    struct Item *item1 = (struct Item *)a;
    struct Item *item2 = (struct Item *)b;
    double ratio1 = item1->ratio;
    double ratio2 = item2->ratio;
    if (ratio1 > ratio2) return -1;
    else if (ratio1 < ratio2) return 1;
    else return 0;
}

// Function to solve discrete Knapsack problem
void discreteKnapsack(struct Item items[], int n, int capacity) {
    int i, j;
    int dp[n + 1][capacity + 1];

    // Initialize the DP table
    for (i = 0; i <= n; i++) {
        for (j = 0; j <= capacity; j++) {
            if (i == 0 || j == 0)
                dp[i][j] = 0;
            else if (items[i - 1].weight <= j)
                dp[i][j] = (items[i - 1].value + dp[i - 1][j - items[i - 1].weight] > dp[i - 1][j]) ?
                           (items[i - 1].value + dp[i - 1][j - items[i - 1].weight]) :
                           dp[i - 1][j];
            else
                dp[i][j] = dp[i - 1][j];
        }
    }

    printf("Total value obtained for discrete knapsack: %d\n", dp[n][capacity]);
}

// Function to solve continuous Knapsack problem
void continuousKnapsack(struct Item items[], int n, int capacity) {
    int i;
    double totalValue = 0.0;
    int remainingCapacity = capacity;
```

```
    for (i = 0; i < n; i++) {
        if (remainingCapacity >= items[i].weight) {
            totalValue += items[i].value;
            remainingCapacity -= items[i].weight;
        } else {
            totalValue += (double)remainingCapacity / items[i].weight * items[i].value;
            break;
        }
    }

    printf("Total value obtained for continuous knapsack: %.2lf\n", totalValue);
}

int main() {
    int n, capacity, i;
    printf("Enter the number of items: ");
    scanf("%d", &n);

    struct Item items[n];

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

    printf("Enter the value and weight of each item:\n");
    for (i = 0; i < n; i++) {
        scanf("%d %d", &items[i].value, &items[i].weight);
        items[i].ratio = (double)items[i].value / items[i].weight;
    }

    // Sort items based on value-to-weight ratio
    qsort(items, n, sizeof(struct Item), compare);

    discreteKnapsack(items, n, capacity);
    continuousKnapsack(items, n, capacity);

    return 0;
}
```

OUTPUT:

```
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of items: 4
Enter the capacity of the knapsack: 10
Enter the value and weight of each item:
42 7
12 3
40 4
25 5
Total value obtained for discrete knapsack: 65
Total value obtained for continuous knapsack: 76.00
```

8.Design and implement C Program to find a subset of a given set S = {sl , s2,.....,sn} of n positive integers whose sum is equal to a given positive integer d.

PROGRAM:

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

#define MAX_SIZE 100

// Function to find subset with given sum
void subsetSum(int set[], int subset[], int n, int subSize, int total, int nodeCount, int sum) {
    if (total == sum) {
        // Print the subset
        printf("Subset found: { ");
        for (int i = 0; i < subSize; i++) {
            printf("%d ", subset[i]);
        }
        printf("}\n");
        return;
    } else {
        // Check the sum of the remaining elements
        for (int i = nodeCount; i < n; i++) {
            subset[subSize] = set[i];
            subsetSum(set, subset, n, subSize + 1, total + set[i], i + 1, sum);
        }
    }
}

int main() {
    int set[MAX_SIZE];
    int subset[MAX_SIZE];
    int n, sum;

    // Input the number of elements in the set
    printf("Enter the number of elements in the set: ");
    scanf("%d", &n);

    // Input the elements of the set
    printf("Enter the elements of the set:\n");
    for (int i = 0; i < n; i++) {
        scanf("%d", &set[i]);
    }

    // Input the target sum
    printf("Enter the sum to find subset for: ");
    scanf("%d", &sum);

    printf("Subsets with sum %d:\n", sum);
    subsetSum(set, subset, n, 0, 0, 0, sum);

    return 0;
```

}

OUTPUT:

```
student@lenovo-ThinkCentre-M900:~$ gcc program8.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements in the set: 5
Enter the elements of the set:
2
4
6
8
10
Enter the sum to find subset for: 10
Subsets with sum 10:
Subset found: { 2 8 }
Subset found: { 4 6 }
Subset found: { 10 }
```

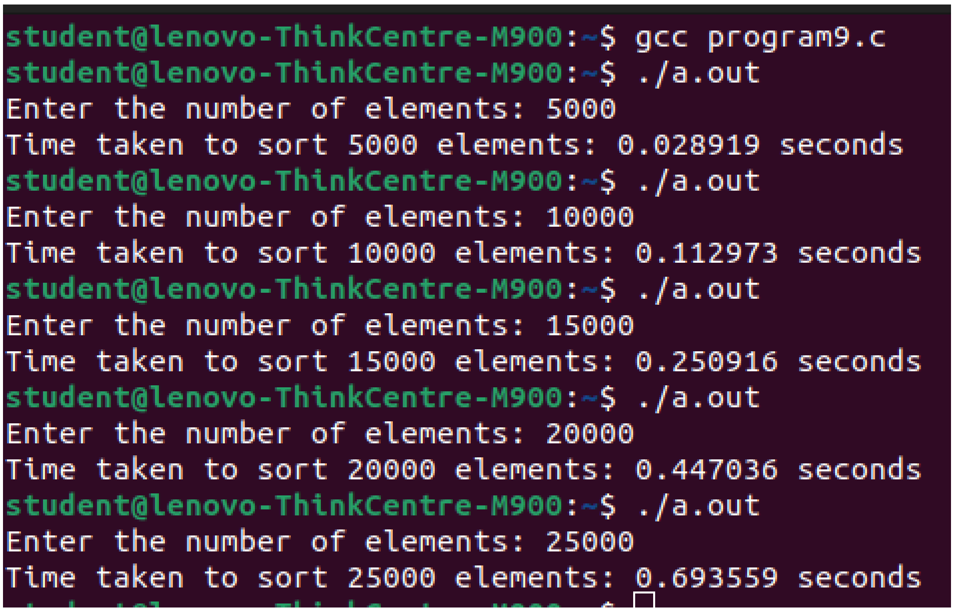
9. Design and implement C Program to sort a given set of n integer elements using Selection Sort method and compute its time complexity. Run the program for varied values of n> 5000 and record the time taken to sort. Plot a graph of the time taken versus n. The elements can be read from a file or can be generated using the random number generator.

PROGRAM:

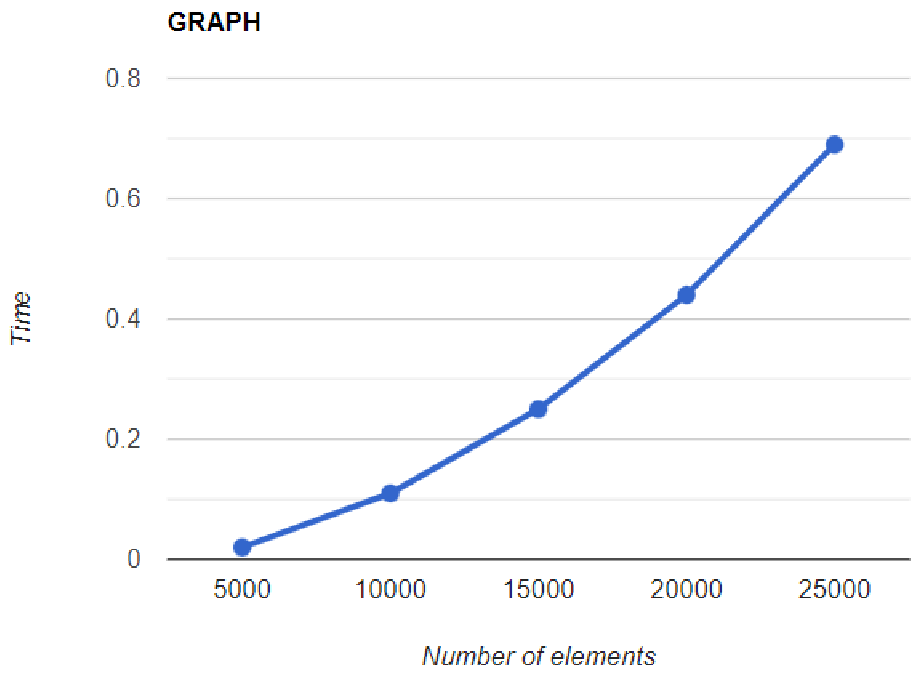
```
#include <stdio.h>
#include <stdlib.h>
#include <time.h>

// Function to perform Selection Sort
void selectionSort(int arr[], int n) {
    int i, j, minIndex, temp;
    for (i = 0; i < n - 1; i++) {
        minIndex = i;
        for (j = i + 1; j < n; j++) {
            if (arr[j] < arr[minIndex]) {
                minIndex = j;
            }
        }
        // Swap the found minimum element with the first element
        temp = arr[minIndex];
        arr[minIndex] = arr[i];
        arr[i] = temp;
    }
}

int main() {
    int n, i;
    clock_t start, end;
    double cpu_time_used;

    printf("Enter the number of elements (n): ");
    scanf("%d", &n);

    if (n < 5000) {
        printf("Please enter a value of n greater than 5000.\n");
        return 1;
    }

    int *arr = (int *)malloc(n * sizeof(int));
    if (arr == NULL) {
        printf("Memory allocation failed.\n");
        return 1;
    }

    // Generate n random numbers
    srand(time(NULL));
    // printf("Randomly generated array: ");
    for (i = 0; i < n; i++) {
        arr[i] = rand() % 10000; // Generating random numbers between 0 to 9999
```

```c
        // printf("%d ", arr[i]);
    }
    // printf("\n");

    // Record the starting time
    start = clock();

    // Perform Selection Sort
    selectionSort(arr, n);

    // Record the ending time
    end = clock();

    // Calculate the time taken
    cpu_time_used = ((double)(end - start)) / CLOCKS_PER_SEC;

    // printf("Sorted array: ");
    // for (i = 0; i < n; i++) {
    //     printf("%d ", arr[i]);
    // }
    // printf("\n");

    printf("Time taken for sorting: %lf seconds\n", cpu_time_used);

    free(arr); // Free dynamically allocated memory
    return 0;
}
```

OUTPUT:



```
student@lenovo-ThinkCentre-M900:~$ gcc program9.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 5000
Time taken to sort 5000 elements: 0.028919 seconds
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 10000
Time taken to sort 10000 elements: 0.112973 seconds
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 15000
Time taken to sort 15000 elements: 0.250916 seconds
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 20000
Time taken to sort 20000 elements: 0.447036 seconds
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 25000
Time taken to sort 25000 elements: 0.693559 seconds
```


GRAPH
0.8
0.6
0.4
0.2
0
Time
5000
10000
15000
20000
25000
Number of elements

10.Design and implement C Program to sort a given set of n integer elements using Quick Sort method and compute its time complexity. Run the program for varied values of n> 5000 and record the time taken to sort. Plot a graph of the time taken versus n. The elements can be read from a file or can be generated using the random number generator.

PROGRAM:

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

// Function to partition the array using Hoare's algorithm
int hoarePartition(int arr[], int l, int r) {
   int pivot = arr[l]; // Pivot is the first element
   int i = l - 1, j = r + 1;

   while (1) {
      do {
         i++;
      } while (arr[i] < pivot);

      do {
         j--;
      } while (arr[j] > pivot);

      if (i >= j)
         return j;

      // Swap arr[i] and arr[j]
      int temp = arr[i];
      arr[i] = arr[j];
      arr[j] = temp;
   }
}

// Function to perform quicksort using Hoare's partition
void quickSort(int arr[], int low, int high) {
   if (low < high) {
      int pi = hoarePartition(arr, low, high);
      quickSort(arr, low, pi);
      quickSort(arr, pi + 1, high);
   }
}

int main() {
   int n, i;
   clock_t start, end;
   double cpu_time_used;
```

```c
    printf("Enter the number of elements (n): ");
    scanf("%d", &n);

    if (n < 5000) {
        printf("Please enter a value of n greater than 5000.\n");
        return 1;
    }

    int *arr = (int *)malloc(n * sizeof(int));
    if (arr == NULL) {
        printf("Memory allocation failed.\n");
        return 1;
    }

    srand(time(NULL));
    for (i = 0; i < n; i++) {
        arr[i] = rand() % 10000;
    }

    start = clock();
    quickSort(arr, 0, n - 1);
    end = clock();

    cpu_time_used = ((double)(end - start)) / CLOCKS_PER_SEC;

    printf("Time taken for sorting: %lf seconds\n", cpu_time_used);

    free(arr);
    return 0;
}
```

OUTPUT:

```
student@lenovo-ThinkCentre-M900:~$ gcc 10.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 5000
Time taken to sort 5000 elements: 0.000557 seconds
student@lenovo-ThinkCentre-M900:~$ gcc 10.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 10000
Time taken to sort 10000 elements: 0.001171 seconds
student@lenovo-ThinkCentre-M900:~$ gcc 10.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 15000
Time taken to sort 15000 elements: 0.001912 seconds
student@lenovo-ThinkCentre-M900:~$ gcc 10.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 20000
Time taken to sort 20000 elements: 0.002697 seconds
student@lenovo-ThinkCentre-M900:~$ gcc 10.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 25000
Time taken to sort 25000 elements: 0.003862 seconds
```

11.Design and implement C Program to sort a given set of n integer elements using Merge Sort method and compute its time complexity. Run the program for varied values of n> 5000, and record the time taken to sort. Plot a graph of the time taken versus n. The elements can be read from a file or can be generated using the random number generator.

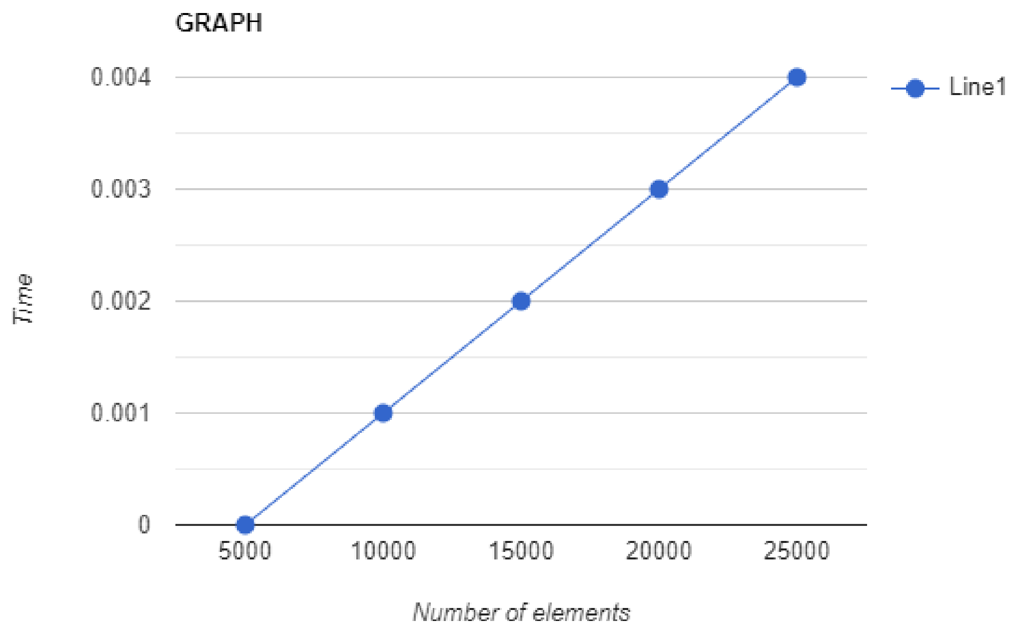
PROGRAM:
L=represents the left index of the subarray
R=represents the right index of the subarray
M=represents the middle index of the subarray
i==it is used to iterate over the elements of the left subarray **L[]**
j==it is used to iterate over the elements of the right subarray **R[]**
k==used to keep track of the current index in the merged array

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

// Merge two subarrays of arr[].
// First subarray is arr[l..m]
// Second subarray is arr[m+1..r]
void merge(int arr[], int l, int m, int r) {
    int i, j, k;
    int n1 = m - l + 1;
    int n2 = r - m;

    // Create temporary arrays
    int L[n1], R[n2];

    // Copy data to temporary arrays L[] and R[]
    for (i = 0; i < n1; i++)
        L[i] = arr[l + i];
    for (j = 0; j < n2; j++)
        R[j] = arr[m + 1 + j];

    // Merge the temporary arrays back into arr[l..r]
    i = 0;
    j = 0;
    k = l;
    while (i < n1 && j < n2) {
        if (L[i] <= R[j]) {
            arr[k] = L[i];
            i++;
        } else {
            arr[k] = R[j];
```

```
            j++;
        }
        k++;
    }

    // Copy the remaining elements of L[], if any
    while (i < n1) {
        arr[k] = L[i];
        i++;
        k++;
    }

    // Copy the remaining elements of R[], if any
    while (j < n2) {
        arr[k] = R[j];
        j++;
        k++;
    }
}

// Merge Sort function
void mergeSort(int arr[], int l, int r) {
    if (l < r) {
        // Same as (l+r)/2, but avoids overflow for large l and r
        int m = l + (r - l) / 2;

        // Sort first and second halves
        mergeSort(arr, l, m);
        mergeSort(arr, m + 1, r);

        // Merge the sorted halves
        merge(arr, l, m, r);
    }
}

int main() {
    int n, i;
    clock_t start, end;
    double cpu_time_used;

    printf("Enter the number of elements (n): ");
    scanf("%d", &n);

    if (n < 5000) {
        printf("Please enter a value of n greater than 5000.\n");
```

```
        return 1;
    }

    int *arr = (int *)malloc(n * sizeof(int));
    if (arr == NULL) {
        printf("Memory allocation failed.\n");
        return 1;
    }

    // Generate n random numbers
    srand(time(NULL));
    // printf("Randomly generated array: ");
    for (i = 0; i < n; i++) {
        arr[i] = rand() % 10000; // Generating random numbers between 0 to 9999
        // printf("%d ", arr[i]);
    }
    // printf("\n");

    // Record the starting time
    start = clock();

    // Perform Merge Sort
    mergeSort(arr, 0, n - 1);

    // Record the ending time
    end = clock();

    // Calculate the time taken
    cpu_time_used = ((double)(end - start)) / CLOCKS_PER_SEC;

    // printf("Sorted array: ");
    // for (i = 0; i < n; i++) {
    //     printf("%d ", arr[i]);
    // }
    // printf("\n");

    printf("Time taken for sorting: %lf seconds\n", cpu_time_used);

    free(arr); // Free dynamically allocated memory
    return 0;
}
```
OUTPUT:

```
student@lenovo-ThinkCentre-M900:~$ gcc 11.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 5000
Time taken to sort 5000 elements: 0.000691 seconds
student@lenovo-ThinkCentre-M900:~$ gcc 11.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 10000
Time taken to sort 10000 elements: 0.001521 seconds
student@lenovo-ThinkCentre-M900:~$ gcc 11.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 15000
Time taken to sort 15000 elements: 0.002262 seconds
student@lenovo-ThinkCentre-M900:~$ gcc 11.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 20000
Time taken to sort 20000 elements: 0.003134 seconds
student@lenovo-ThinkCentre-M900:~$ gcc 11.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 25000
Time taken to sort 25000 elements: 0.003956 seconds
```



12.Design and implement C Program for N Queen's problem using Backtracking

PROGRAM:

```
#include<stdio.h>
#include<math.h>
#include<stdlib.h>
int board[20],count;

int main()
{
int n,i,j;
void queen(int row,int n);

printf(" - N Queens Problem Using Backtracking -");
printf("\n\nEnter number of Queens:");
scanf("%d",&n);
queen(1,n);
return 0;
}

//function for printing the solution
void print(int n)
{
int i,j;
printf("\n\nSolution %d:\n\n",++count);

for(i=1;i<=n;++i)
  printf("\t%d",i);

for(i=1;i<=n;++i)
{
  printf("\n\n%d",i);
  for(j=1;j<=n;++j) //for nxn board
  {
   if(board[i]==j)
    printf("\tQ"); //queen at i,j position
   else
    printf("\t-"); //empty slot
  }
}
}

/*funtion to check conflicts
If no conflict for desired postion returns 1 otherwise returns 0*/
int place(int row,int column)
{
int i;
for(i=1;i<=row-1;++i)
{
  //checking column and digonal conflicts
  if(board[i]==column)
   return 0;
```

```
  else
   if(abs(board[i]-column)==abs(i-row))
    return 0;
}

return 1; //no conflicts
}

//function to check for proper positioning of queen
void queen(int row,int n)
{
int column;
for(column=1;column<=n;++column)
{
  if(place(row,column))
  {
   board[row]=column; //no conflicts so place queen
   if(row==n) //dead end
    print(n); //printing the board configuration
   else //try queen with next position
    queen(row+1,n);
  }
}
}
```

OUTPUT:

```
student@lenovo-ThinkCentre-M900:~$ gedit 12.c
student@lenovo-ThinkCentre-M900:~$ gcc 12.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
 - N Queens Problem Using Backtracking -

Enter number of Queens:4


Solution 1:

        1       2       3       4

1       -       Q       -       -

2       -       -       -       Q

3       Q       -       -       -

4       -       -       Q       -

Solution 2:

        1       2       3       4

1       -       -       Q       -

2       Q       -       -       -

3       -       -       -       Q

4       -       Q       -       -student@lenov
```