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

// Structure to represent an edge in the graph
typedef struct Edge {
    int src, dest, weight;
} Edge;


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

// Structure to represent a subset for union-find
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;
}
// Function to find the root of the set the vertex belongs to
int find(Subset subsets[], int i) {
    if (subsets[i].parent != i) {
        subsets[i].parent = find(subsets, subsets[i].parent);
    }
    return subsets[i].parent;
```

```
}

// Function to perform union of two sets

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

    // Attach smaller rank tree under root of larger rank tree
    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++;
    }
}
// Function to compare two edges by weight
int compare(const void* a, const void* b) {
    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;

    //Sort the edges by weight
    qsort(graph->edges, graph->E, sizeof(Edge), compare);

    // Allocate memory for subsets
    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);
  // Check if adding edge creates a cycle
        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;
}
```

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' 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/C++ Program to obtain the Topological ordering of vertices in a given digraph.

```
#include  <stdio.h>
#include <stdlib.h>
#define MAX 100

int graph[MAX][MAX];  // Adjacency matrix
int visited[MAX];     // Visited array
int stack[MAX];       // Stack to store the topological order
int stackIndex = 0;   // Stack index

void addEdge(int src, int dest)
{
graph[src][dest] = 1;
}

// A recursive function to perform DFS and push vertices to stack
void dfs(int v, int V) {
    visited[v] = 1;
    for (int i = 0; i < V; i++) {
        if (graph[v][i] && !visited[i])
        {
        dfs(i, V);
        }
    }

    stack[stackIndex++] = v;
}
// The function to perform Topological Sort
void topologicalSort(int V)
{
    for (int i = 0; i < V; i++) {
        if (!visited[i]) {
            dfs(i, V);
        }
    }
    for (int i = stackIndex - 1; i >= 0; i--) {
        printf("%d ", stack[i]);
    }
    printf("\n");
}
```

```
int main() {
    int V = 6;                    // Number of vertices
    for (int i = 0; i < V; i++) {
        for (int j = 0; j < V; j++) {
            graph[i][j] = 0;          // Initialize graph adjacency matrix to 0
        }
        visited[i] = 0;  // Initialize visited array to 0
    }

    addEdge(5, 2);
    addEdge(5, 0);
    addEdge(4, 0);
    addEdge(4, 1);
    addEdge(2, 3);
    addEdge(3, 1);
    printf("Topological sorting of the given graph is: \n");
    topologicalSort(V);
    return 0;
}
```

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, j;
    int K[n + 1][W + 1];

    // Build table K[][] in bottom-up manner
    for (i = 0; i <= n; i++) {
```

```
        for (j = 0; j <= W; j++) {
            if (i == 0 || j == 0)
                K[i][j] = 0;
            else if (wt[i - 1] <= j)
                K[i][j] = max(val[i - 1] + K[i - 1][j - wt[i - 1]], K[i - 1][j]);
            else
                K[i][j] = K[i - 1][j];
        }
    }

    // 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
```

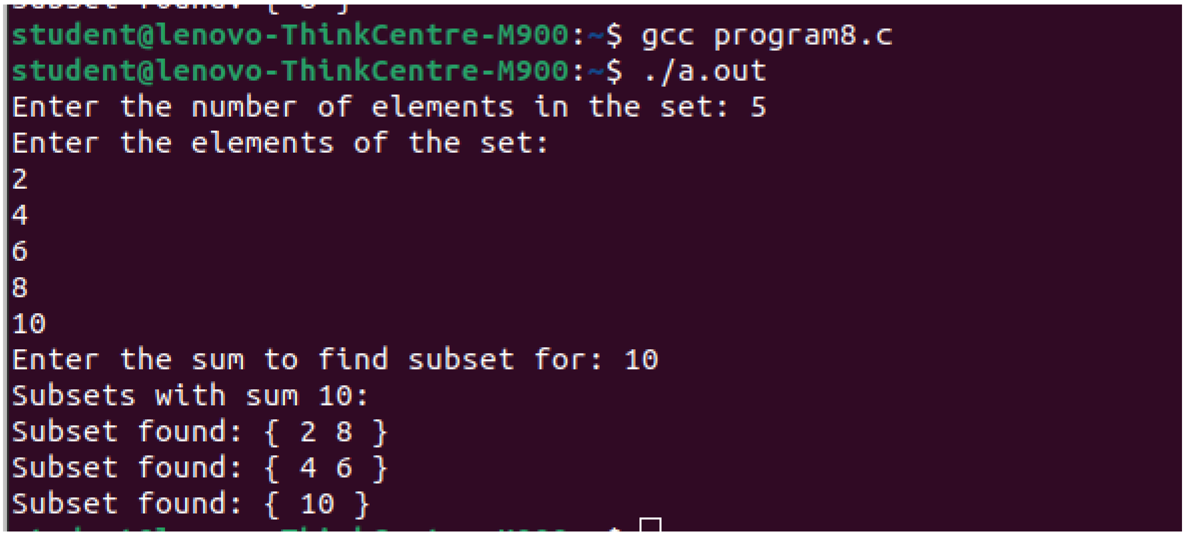
8. Design and implement C Program to find a subset of a given set S = {sl , s2,.....,sn} of n positive integers whose sum is equal to a given positive integer d.

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:

ALGORITHM *SelectionSort*($A[0..n-1]$)
//Sorts a given array by selection sort
//Input: An array $A[0..n-1]$ of orderable elements
//Output: Array $A[0..n-1]$ sorted in nondecreasing order
for $i \leftarrow 0$ **to** $n-2$ **do**
  $min \leftarrow i$
  for $j \leftarrow i+1$ **to** $n-1$ **do**
    if $A[j] < A[min]$ $min \leftarrow j$
  swap $A[i]$ and $A[min]$

```
#include<stdio.h>
#include<stdlib.h>
#include <time.h>
 void selectionSort(int arr[], int n) {
    int i, j, min_idx;
    for (i = 0; i < n-1; i++)
    {
    min_idx = i;
        for (j = i+1; j < n; j++) {
            if (arr[j] < arr[min_idx])
             {
            min_idx = j;
            }
        }
        // Swap the found minimum element with the first element
        int temp = arr[min_idx];
        arr[min_idx] = arr[i];
        arr[i] = temp;
    }
 }
 int main() {
    int n;
    printf("Enter the number of elements: ");
    scanf("%d", &n);

    // Dynamic memory allocation for the array
    int *arr = (int*)malloc(n * sizeof(int));
```

```
    // Generate random numbers for the array
    srand(time(NULL));
    for (int i = 0; i < n; i++)
    {
        arr[i] = rand() % 1000;  // Generate random numbers between 0 and
999
    }
    clock_t start = clock();     // Start the timer
 selectionSort(arr, n);         // Sort the array
 clock_t end = clock();     // End the timer
    // Calculate the time taken
    double time_taken = ((double)(end - start)) / CLOCKS_PER_SEC;
    printf("Sorted array: ");
    for (int i = 0; i < n; i++)
    {
    printf("%d  ", arr[i]);
    }
    printf("\n");
    printf("Time taken: %f seconds\n", time_taken);
    // Free dynamically allocated memory
    free(arr);
    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
```

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:

ALGORITHM *Quicksort*($A[l..r]$)

//Sorts a subarray by quicksort
//Input: Subarray of array $A[0..n-1]$, defined by its left and right
// indices l and r
//Output: Subarray $A[l..r]$ sorted in nondecreasing order
if $l < r$
 $s \leftarrow Partition(A[l..r])$ //s is a split position
 $Quicksort(A[l..s-1])$
 $Quicksort(A[s+1..r])$

```
// C program to implement Quick Sort Algorithm
#include  <stdio.h>
#include <stdlib.h>
#include <time.h>
void quickSort(int arr[], int left, int right) {
    if (left >= right) return;
    int   pivot   =   arr[right];
    int partitionIndex = left;
    for (int i = left; i < right; i++) {
        if (arr[i] < pivot) {
            int temp = arr[i];
            arr[i] = arr[partitionIndex];
            arr[partitionIndex] = temp;
            partitionIndex++;
```

```
        }
    }
    int temp = arr[partitionIndex];
    arr[partitionIndex] = arr[right];
    arr[right] = temp;
    quickSort(arr, left, partitionIndex - 1);
    quickSort(arr, partitionIndex + 1, right);
}

void generateRandomData(int arr[], int n) {
    for (int i = 0; i < n; i++) {
        arr[i] = rand() % 100000; // Random numbers between 0 and 99999
    }
}
int main() {
    srand(time(0)); // Seed for random number generation

    printf("n \t Time (seconds)\n");
    printf("-----------------\n");

    for (int n = 5000; n <= 50000; n += 5000) {
        int *arr = (int *)malloc(n * sizeof(int));
        if (!arr) {
            printf("Memory allocation failed for %d elements.\n", n);
            return 1;
        }
        generateRandomData(arr, n);

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

        double time_taken = (double)(end - start) / CLOCKS_PER_SEC;
        printf("%d \t %f\n", n, time_taken);

        free(arr);
    }

    return 0;
}
```

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:

ALGORITHM *Mergesort*($A[0..n-1]$)

//Sorts array $A[0..n-1]$ by recursive mergesort
//Input: An array $A[0..n-1]$ of orderable elements
//Output: Array $A[0..n-1]$ sorted in nondecreasing order
if $n > 1$
    copy $A[0..\lfloor n/2\rfloor - 1]$ to $B[0..\lfloor n/2\rfloor - 1]$
    copy $A[\lfloor n/2\rfloor..n-1]$ to $C[0..\lceil n/2\rceil - 1]$
    Mergesort($B[0..\lfloor n/2\rfloor - 1]$)
    Mergesort($C[0..\lceil n/2\rceil - 1]$)
    Merge(B, C, A)   //see below

ALGORITHM *Merge*($B[0..p-1]$, $C[0..q-1]$, $A[0..p+q-1]$)

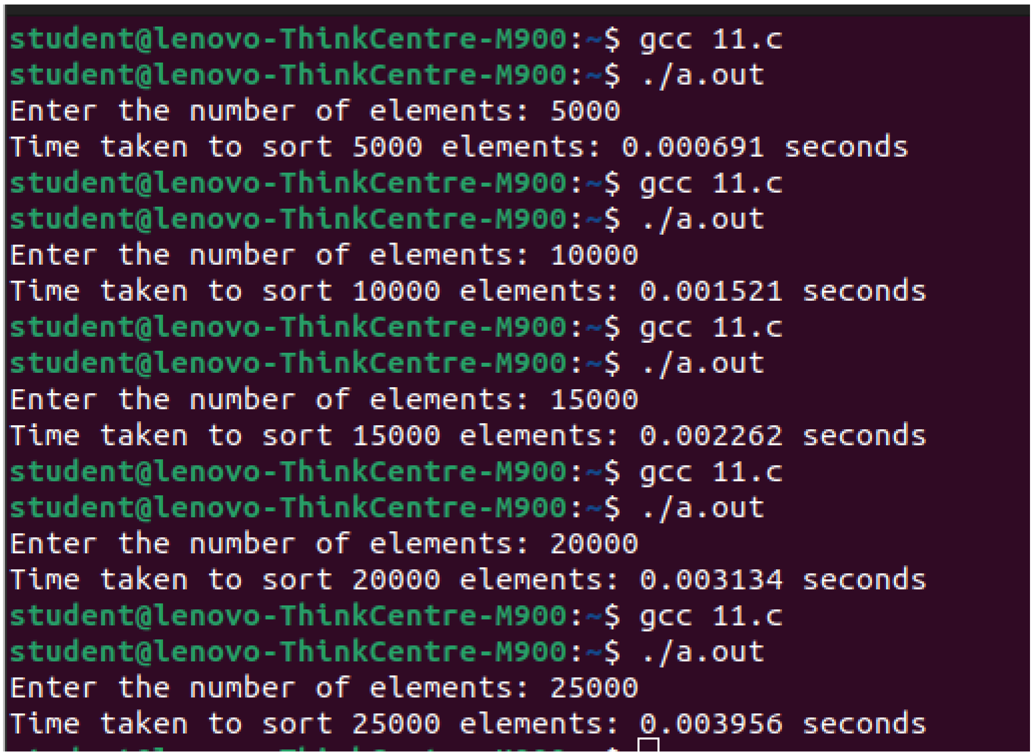
//Merges two sorted arrays into one sorted array
//Input: Arrays $B[0..p-1]$ and $C[0..q-1]$ both sorted
//Output: Sorted array $A[0..p+q-1]$ of the elements of B and C
$i \leftarrow 0$; $j \leftarrow 0$; $k \leftarrow 0$
while $i < p$ **and** $j < q$ **do**
    if $B[i] \le C[j]$
        $A[k] \leftarrow B[i]$; $i \leftarrow i+1$
    else $A[k] \leftarrow C[j]$; $j \leftarrow j+1$
    $k \leftarrow k+1$
if $i = p$
    copy $C[j..q-1]$ to $A[k..p+q-1]$
else copy $B[i..p-1]$ to $A[k..p+q-1]$

```
#include  <stdio.h>
#include <stdlib.h>
#include <time.h>
// Function to merge two subarrays of arr[]
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 there are any
    while (i < n1) {
        arr[k] = L[i];
        i++;
        k++;
    }

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

// Main function to implement Merge Sort
```

```
void mergeSort(int arr[], int l, int r) {
    if (l < r) {
        // Find the middle point
        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;
    printf("Enter the number of elements: ");
    scanf("%d", &n);

    // Dynamically allocate memory for the array
    int *arr = (int *)malloc(n * sizeof(int));

    // Generate random numbers and fill the array
    srand(time(NULL));
    for (int i = 0; i < n; i++) {
        arr[i] = rand() % 100000; // Adjust range as needed
    }

    // Measure the time taken for sorting
    clock_t start = clock();
    mergeSort(arr, 0, n - 1);
    clock_t end = clock();
    double time_taken = ((double)(end - start)) / CLOCKS_PER_SEC;
    printf("Time taken to sort %d elements: %f seconds\n", n, time_taken);

    // Free dynamically allocated memory
    free(arr);
    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
```

11. 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\n Enter 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
  }
}
}

/*function 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 diagonal 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
```