DOMAIN WINTER WINNING CAMP

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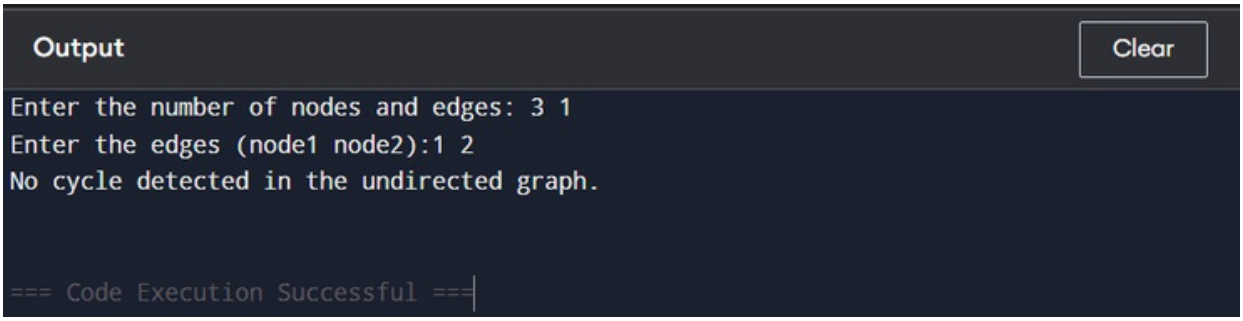
1. Write a program to detect a cycle in the undirected graph

```
#include
<iostream>
#include
<iostream>     using
namespace std;
const int MAX_NODES = 100;
int adj[MAX_NODES][MAX_NODES] = {0};
bool visited[MAX_NODES];
bool dfsCycleUndirected(int node, int parent, int n) {
    visited[node] = true;
    for (int neighbor = 1; neighbor <= n; ++neighbor) {
        if (adj[node][neighbor]) {
            if (!visited[neighbor]) {
                if (dfsCycleUndirected(neighbor, node, n)) {
                    return true;
                }
            } else if (neighbor != parent) {
                return true;
            }
        }
    }
    return false;
}

int main() {
    int n, edges;
    cout << "Enter the number of nodes and edges: ";
    cin >> n >> edges;

    cout << "Enter the edges (node1 node2):";
    for (int i = 0; i < edges; ++i) {
        int u, v;
        cin >> u >> v;
        adj[u][v] = adj[v][u] = 1;
    }

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

```
    visited[i] = false;
  }
  bool hasCycle = false;
  for (int i = 1; i <= n; ++i) {
    if (!visited[i]) {
      if (dfsCycleUndirected(i, -1, n)) {
        hasCycle = true;
        break;
      }
    }
  }
  if (hasCycle) {
    cout << "Cycle detected in the undirected graph." << endl;
  } else {
    cout << "No cycle detected in the undirected graph." << endl;
  }

  return 0;
}
```



2. Write a program to detect a cycle in the directed graph

```
#include <iostream>
using namespace std;

const int MAX_NODES = 100;
int adj[MAX_NODES][MAX_NODES] = {0};
bool visited[MAX_NODES];
bool recStack[MAX_NODES]; // To track nodes in the current recursion stack

bool dfsCycleDirected(int node, int n) {
  visited[node] = true;
  recStack[node] = true;

  for (int neighbor = 1; neighbor <= n; ++neighbor) {
    if (adj[node][neighbor]) {
      if (!visited[neighbor]) {
        if (dfsCycleDirected(neighbor, n)) {
          return true;
        }
```

```
            } else if (recStack[neighbor]) {
                return true;
            }
        }
    }
    recStack[node] = false; // Remove the node from recursion stack
    return false;
}
int main() {
    int n, edges;
    cout << "Enter the number of nodes and edges: " << endl;
    cin >> n >> edges;

    cout << "Enter the edges (node1 node2):" << endl;
    for (int i = 0; i < edges; ++i) {
        int u, v;
        cin >> u >> v;
        adj[u][v] = 1; // Directed edge from u to v
    }
    for (int i = 1; i <= n; ++i) {
        visited[i] = false;
        recStack[i] = false;
    }
    bool hasCycle = false;
    for (int i = 1; i <= n; ++i) {
        if (!visited[i]) {
            if (dfsCycleDirected(i, n)) {
                hasCycle = true;
                break;
            }
        }
    }
    if (hasCycle) {
        cout << "Cycle detected in the directed graph." << endl;
    } else {
        cout << "No cycle detected in the directed graph." << endl;
    }
    return 0;
}
```

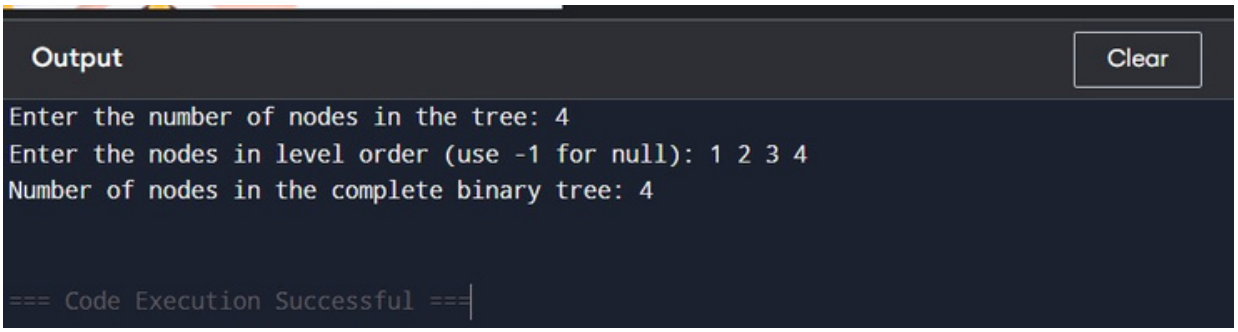
Output Clear

```
Enter the number of nodes and edges: 4 3
Enter the edges (node1 node2): 1 2
2 3
3 4
No cycle detected in the directed graph.

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

3. Given the root of a complete binary tree, return the number of nodes in tree

```
#include <iostream>
#include <cmath>
using namespace std;

struct TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode(int value) : val(value), left(nullptr), right(nullptr) {}
};

int getHeight(TreeNode* root) {
    int height = 0;
    while (root) {
        height++;
        root = root->left;
    }
    return height;
}

int countNodes(TreeNode* root) {
    if (!root) return 0;
    int leftHeight = getHeight(root->left);
    int rightHeight = getHeight(root->right);

    if (leftHeight == rightHeight) {
        return (1 << leftHeight) + countNodes(root->right);
    } else {
        return (1 << rightHeight) + countNodes(root->left);
    }
}

TreeNode* insertLevelOrder(int arr[], int n, int i) {
    if (i >= n) return nullptr;
    TreeNode* root = new TreeNode(arr[i]);
    root->left = insertLevelOrder(arr, n, 2 * i + 1);
    root->right = insertLevelOrder(arr, n, 2 * i + 2);
    return root;
}

int main() {
    int n;
    cout << "Enter the number of nodes in the tree: ";
    cin >> n;
    int arr[n];
    cout << "Enter the nodes in level order (use -1 for null): ";
```

```
    for (int i = 0; i < n; ++i) {
        cin >> arr[i];
    }
    TreeNode* root = insertLevelOrder(arr, n, 0);
    cout << "Number of nodes in the complete binary tree: " << countNodes(root) << endl;

    return 0;
}
```



4. Given the root of a binary tree, return the preorder of the nodes values

```
#include <iostream>
#include <vector>
using namespace std;

struct TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode(int value) : val(value), left(nullptr), right(nullptr) {}
};

void preorderTraversal(TreeNode* root, vector<int>& result) {
    if (!root) return;
    result.push_back(root->val);
    preorderTraversal(root->left, result);
    preorderTraversal(root->right, result);
}

TreeNode* insertLevelOrder(int arr[], int n, int i) {
    if (i >= n || arr[i] == -1) return nullptr;
    TreeNode* root = new TreeNode(arr[i]);
    root->left = insertLevelOrder(arr, n, 2 * i + 1);
    root->right = insertLevelOrder(arr, n, 2 * i + 2);
    return root;
}
int main() {
    int n;
    cout << "Enter the number of nodes in the tree: ";
    cin >> n;
```

```
    int arr[n];
    cout << "Enter the nodes in level order (use -1 for null): ";
    for (int i = 0; i < n; ++i) {
        cin >> arr[i];
    }

    TreeNode* root = insertLevelOrder(arr, n, 0);

    vector<int> result;
    preorderTraversal(root, result);

    cout << "Preorder traversal: ";
    for (int val : result) {
        cout << val << " ";
    }
    cout << endl;

    return 0;
}
```

```
Output                                                    Clear
Enter the number of nodes in the tree: 4
Enter the nodes in level order (use -1 for null): 1 2 3 4
Preorder traversal: 1 2 4 3


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

5. Given the root of a binary tree, you need to find the sum of all the node values in the binary tree.

```
#include <iostream>
#include <sstream>
using namespace std;

struct TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode(int x) : val(x), left(nullptr), right(nullptr) {}
};
TreeNode* buildTree(const string& input, int& index) {
    if (index >= input.size() || input[index] == ',') {
        index++;
        return nullptr;
    }
    int num = 0;
    while (index < input.size() && input[index] != ',' && input[index] != ' ') {
        num = num * 10 + (input[index] - '0');
        index++;
```

```
    }
    TreeNode* node = new TreeNode(num);
    node->left = buildTree(input, index);
    node->right = buildTree(input, index);
    return node;
}
int sumOfNodes(TreeNode* root) {
    if (!root) return 0;
    return root->val + sumOfNodes(root->left) + sumOfNodes(root->right);
}
int main() {
    string input;
    cout << "Enter the tree nodes (comma separated): ";
    getline(cin, input);
    int index = 0;
    TreeNode* root = buildTree(input, index);
    int sum = sumOfNodes(root);
    cout << "Sum of all nodes: " << sum << endl;
    return 0;
}
```

```
Output                                                    Clear
Enter the tree nodes (comma separated): 1,2,3,4,5
Sum of all nodes: 15


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

6. Implement DFS for a binary tree

```
#include <iostream>
using namespace std;

struct TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode(int value) : val(value), left(nullptr), right(nullptr) {}
};

void dfs(TreeNode* root) {
    if (!root) return;
    cout << root->val << " ";
    dfs(root->left);
    dfs(root->right);
}

TreeNode* insertLevelOrder(int arr[], int n, int i) {
```

```
    if (i >= n || arr[i] == -1) return nullptr;
    TreeNode* root = new TreeNode(arr[i]);
    root->left = insertLevelOrder(arr, n, 2 * i + 1);
    root->right = insertLevelOrder(arr, n, 2 * i + 2);
    return root;
}

int main() {
    int n;
    cout << "Enter the number of nodes in the tree:";
    cin >> n;
    int arr[n];
    cout << "Enter the nodes in level order (use -1 for null):";
    for (int i = 0; i < n; ++i) {
        cin >> arr[i];
    }

    TreeNode* root = insertLevelOrder(arr, n, 0);
    cout << "DFS traversal: ";
    dfs(root);
    cout << endl;
    return 0;
}
```

```
Output                                                    Clear
Enter the number of nodes in the tree:3
Enter the nodes in level order (use -1 for null):1 2 -1
DFS traversal: 1 2


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

7. Given a Binary Tree, the task is to count leaves of the tree if both left and right child nodes are NULL.

```
#include <iostream>
#include <sstream>
using namespace std;

struct TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode(int x) : val(x), left(nullptr), right(nullptr) {}
};
TreeNode* buildTree(const string& nodes) {
    if (nodes.empty()) {
        return nullptr;
    }
```

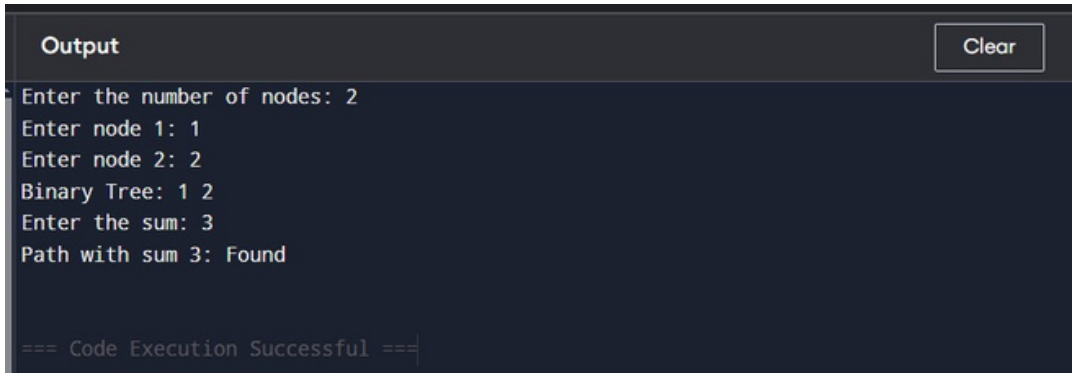
```
istringstream iss(nodes);
    string token;
    iss >> token;
    int val = atoi(token.c_str());
    TreeNode* root = new TreeNode(val);

    TreeNode* current = root;
    while (iss >> token) {
        int val = atoi(token.c_str());
        TreeNode* newNode = new TreeNode(val);
        if (!current->left) {

            current->left = newNode;
        } else {
            current->right = newNode;
            current = root;
            while (current->left && current->right) {
                current = current->left;
            }
        }
    }
    return root;
}
int countLeaves(TreeNode* root) {

    if (!root) {
        return 0;
    }
    if (!root->left && !root->right) {
        return 1;
    }
    return countLeaves(root->left) + countLeaves(root->right);
}

void deleteTree(TreeNode* root) {
    if (!root) {
        return;
    }
    deleteTree(root->left);
    deleteTree(root->right);
    delete root;
}
int main() {

    cout << "Enter tree nodes separated by spaces: ";
    string input;
    getline(cin, input);
    TreeNode* root = buildTree(input);
    if (!root) {

        cout << "Invalid input." << endl;
```

```
    return 1;
  }
  int numLeaves = countLeaves(root);
  cout << "Number of leaves: " << numLeaves << endl;
  deleteTree(root);

  return 0;
}
```

8. Create a cyclic graph

```
#include <iostream>
using namespace std;

struct TreeNode {
  int val;
  TreeNode *left;
  TreeNode *right;
  TreeNode(int x) : val(x), left(NULL), right(NULL) {}
};
class Solution {
public:
  bool hasPathSum(TreeNode* root, int sum) {
    if (!root) return false;
    return dfs(root, sum);
  }
  bool dfs(TreeNode* node, int sum) {

    if (!node) return false;
    if (!node->left && !node->right && node->val == sum) return true;
    return dfs(node->left, sum - node->val) || dfs(node->right, sum - node->val);
  }
};
TreeNode* createNode(int val) {

  TreeNode* newNode = new TreeNode(val);
  return newNode;
}
void insertNode(TreeNode** root, int val) {

  if (*root == NULL) *root = createNode(val);
  else if (val < (*root)->val) {
```

```
        if ((*root)->left == NULL) (*root)->left = createNode(val);
        else insertNode(&((*root)->left), val);
    } else {
        if ((*root)->right == NULL) (*root)->right = createNode(val);
        else insertNode(&((*root)->right), val);
    }
}
void printTree(TreeNode* root) {
    if (root == NULL) return;
    cout << root->val << " ";
    printTree(root->left);
    printTree(root->right);
}
int main() {
    Solution solution;
    TreeNode* root = NULL;
    int n;
    cout << "Enter the number of nodes: ";
    cin >> n;
    for (int i = 0; i < n; i++) {
        int val;
        cout << "Enter node " << i + 1 << ": ";
        cin >> val;
        insertNode(&root, val);
    }

    cout << "Binary Tree: ";
    printTree(root);
    cout << endl;

    int sum;
    cout << "Enter the sum: ";
    cin >> sum;

    bool result = solution.hasPathSum(root, sum);

    cout << "Path with sum " << sum << ": " << (result ? "Found" : "Not Found") << endl;

    return 0;
}
```



9. Find the centre of the star graph

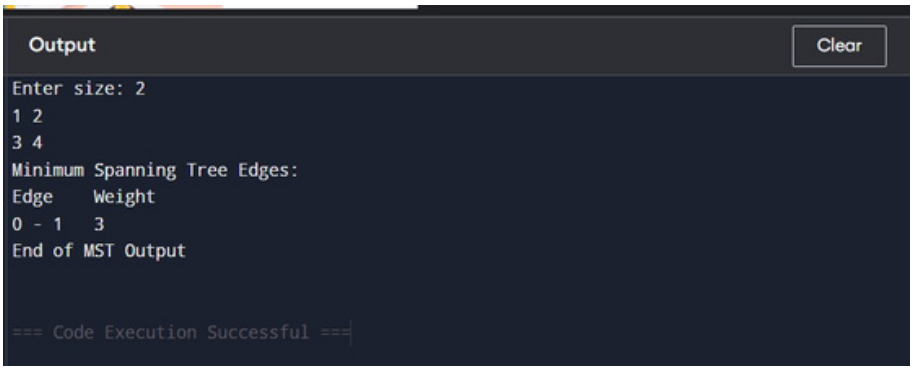
```
#include <iostream>
#include <cstring>
using namespace std;

const int MAX = 100;
int graph[MAX][MAX];
int findCenter(int n) {
int maxDegree = 0;
int centerNode = -1;

for (int i = 0; i < n; ++i) {
        int degree = 0;
        for (int j = 0; j < n; ++j) {
            if (graph[i][j]) degree++;
        }
        if (degree > maxDegree) {
        maxDegree = degree;
        centerNode = i;
        }
    }
    return centerNode;
}
int main() {

    int n, m;
    cout << "Enter the number of vertices and edges: ";
    cin >> n >> m;
    memset(graph, 0, sizeof(graph));
    cout << "Enter the edges (u v) for the undirected graph:\n";
    for (int i = 0; i < m; ++i) {
        int u, v;
        cin >> u >> v;
        graph[u][v] = graph[v][u] = 1;
    }
    int centerNode = findCenter(n);
    cout << "The center of the star graph is: " << centerNode << endl;

    return 0;
}
```

```
Output                                                    Clear
Enter the number of vertices and edges: 5 4
Enter the edges (u v) for the undirected graph:
0 1
0 2
0 3
0 4
The center of the star graph is: 0


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

10.Write a program to find minimum spanning tree.

```
#include <iostream>
#include <climits>
using namespace std;

void primMST(int graph[100][100], int n) {
   int key[n];
   bool inMST[n];
   int parent[n];
   int min_index;

   for (int i = 0; i < n; ++i) {
   key[i] = INT_MAX;
   inMST[i] = false;
   parent[i] = -1;
   }
   key[0] = 0;

   for (int count = 0; count < n - 1; ++count) {
      int minKey = INT_MAX;
      min_index = -1;

      for (int v = 0; v < n; ++v) {
         if (!inMST[v] && key[v] < minKey) {
            minKey = key[v];
            min_index = v;
         }
      }
      inMST[min_index] = true;
      for (int v = 0; v < n; ++v) {
         if (graph[min_index][v] && !inMST[v] && graph[min_index][v] < key[v]) {
            key[v] = graph[min_index][v];
            parent[v] = min_index;
         }
      }
   }
   cout << "Minimum Spanning Tree Edges:\n";
   cout << "Edge \tWeight\n";
   for (int i = 1; i < n; ++i) {
      cout << parent[i] << " - " << i << "\t" << graph[i][parent[i]] << "\n";
   }
   cout << "End of MST Output\n";
}
int main() {
   int n;
   cout<<"Enter size: ";
   cin >> n;
```

```
    int graph[100][100];
    for (int i = 0; i < n; ++i) {
        for (int j = 0; j < n; ++j) {
            cin >> graph[i][j];
        }
    }

    primMST(graph, n);

    return 0;
}
```



11.Write a program to count the number of connect components in an undirected graph

```
#include <iostream>
using namespace std;

void dfs(int node, int graph[100][100], bool visited[], int n) {
    visited[node] = true;
    for (int neighbor = 0; neighbor < n; ++neighbor) {
        if (graph[node][neighbor] && !visited[neighbor]) {
            dfs(neighbor, graph, visited, n);
        }
    }
}

int countConnectedComponents(int n, int graph[100][100]) {
    bool visited[n];
    for (int i = 0; i < n; ++i) {
        visited[i] = false;
    }

    int count = 0;
    for (int i = 0; i < n; ++i) {
        if (!visited[i]) {
```

```
            ++count;
            dfs(i, graph, visited, n);
        }
    }
    return count;
}

int main() {
    int n, e;
    cout << "Enter number of vertices and edges: ";
    cin >> n >> e;

    int graph[100][100] = {0};
    cout << "Enter edges (u v):\n";
    for (int i = 0; i < e; ++i) {
        int u, v;
        cin >> u >> v;
        graph[u][v] = 1;
        graph[v][u] = 1;
    }

    int result = countConnectedComponents(n, graph);
    cout << "Number of connected components: " << result << endl;

    return 0;
}
```

12.Write a program to check the graph is tree or not

```
#include <iostream>
using namespace std;

void dfs(int node, int graph[100][100], bool visited[], int n) {
    visited[node] = true;
    for (int neighbor = 0; neighbor < n; ++neighbor) {
        if (graph[node][neighbor] && !visited[neighbor]) {
            dfs(neighbor, graph, visited, n);
        }
    }
```

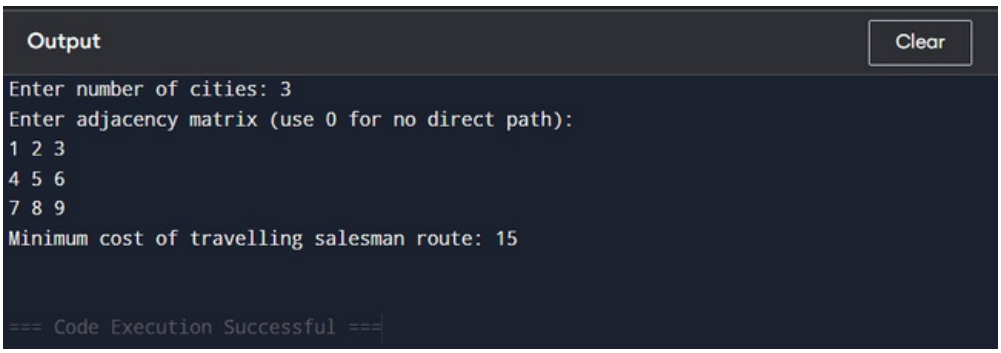
```
}

bool isConnected(int n, int graph[100][100]) {
    bool visited[n];
    for (int i = 0; i < n; ++i) visited[i] = false;

    dfs(0, graph, visited, n);

    for (int i = 0; i < n; ++i) {
        if (!visited[i]) return false;
    }
    return true;
}

bool hasCycle(int n, int graph[100][100], int node, bool visited[], int parent) {
    visited[node] = true;
    for (int neighbor = 0; neighbor < n; ++neighbor) {
        if (graph[node][neighbor]) {
            if (!visited[neighbor]) {
                if (hasCycle(n, graph, neighbor, visited, node)) return true;
            } else if (neighbor != parent) {
                return true;
            }
        }
    }
    return false;
}

bool isTree(int n, int e, int graph[100][100]) {
    if (e != n - 1) return false;

    if (!isConnected(n, graph)) return false;

    bool visited[n];
    for (int i = 0; i < n; ++i) visited[i] = false;

    if (hasCycle(n, graph, 0, visited, -1)) return false;

    return true;
}

int main() {
    int n, e;
    cout << "Enter number of vertices and edges: ";
    cin >> n >> e;

    int graph[100][100] = {0};
    cout << "Enter edges (u v):\n";
```

```
    for (int i = 0; i < e; ++i) {
        int u, v; cin >>
        u >> v;
        graph[u][v] = 1;
        graph[v][u] = 1;
    }

    if (isTree(n, e, graph)) {
        cout << "The graph is a tree.\n";
    } else {
        cout << "The graph is not a tree.\n";
    }

    return 0;
}
```

13.Write a program to solve travelling salesman problem

```
#include <iostream>
#include <climits>
#include <cmath>
using namespace std;

const int INF = INT_MAX;
const int MAX = 16;
int graph[MAX][MAX];
int dp[MAX][1 << MAX];

int tsp(int pos, int visited, int n) {
    if (visited == (1 << n) - 1) return graph[pos][0];
    if (dp[pos][visited] != -1) return dp[pos][visited];
    int minCost = INF;
    for (int city = 0; city < n; ++city) {
        if ((visited & (1 << city)) == 0 && graph[pos][city] > 0) {
            int cost = graph[pos][city] + tsp(city, visited | (1 << city), n);
            minCost = min(minCost, cost);
        }
```

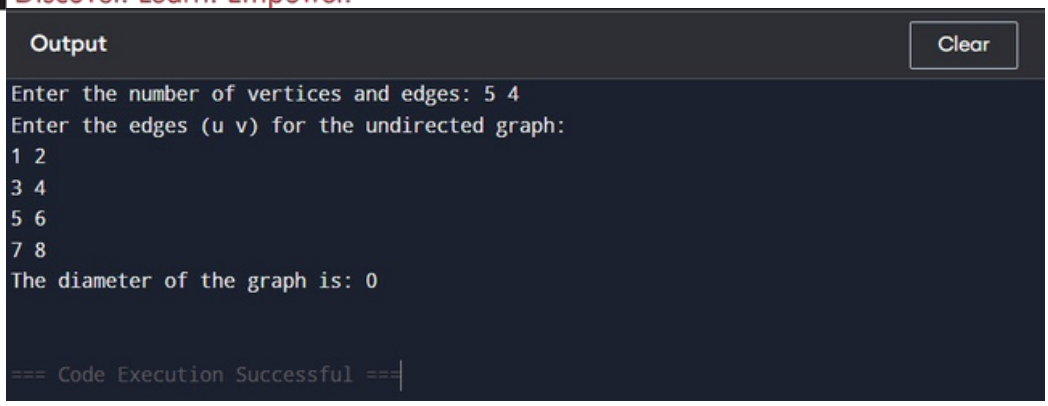
```
    }
    return dp[pos][visited] = minCost;
}

int main() {
    int n;
    cout << "Enter number of cities: ";
    cin >> n;

    cout << "Enter adjacency matrix (use 0 for no direct path):\n";
    for (int i = 0; i < n; ++i) {
        for (int j = 0; j < n; ++j) {
            cin >> graph[i][j];
        }
    }

    for (int i = 0; i < n; ++i) {
        for (int j = 0; j < (1 << n); ++j) {
            dp[i][j] = -1;
        }
    }

    int result = tsp(0, 1, n);
    cout << "Minimum cost of travelling salesman route: " << result << endl;

    return 0;
}
```



14.Write a program to find the diameter of a undirected graph. Use BFS and DFS

```
#include <iostream>
#include <cstring>
using namespace std;

const int MAX = 100;
int graph[MAX][MAX];
bool visited[MAX];
int maxDist, farthestNode;
```

```
void dfs(int node, int dist, int n) {
   visited[node] = true;
   if (dist > maxDist) {
   maxDist = dist;
   farthestNode = node;
   }
   for (int i = 0; i < n; ++i) {
      if (graph[node][i] && !visited[i]) {
         dfs(i, dist + 1, n);
      }
   }
}

int findDiameterDFS(int n) {
   memset(visited, false, sizeof(visited));
   maxDist = 0;
   dfs(0, 0, n);

   memset(visited, false, sizeof(visited));
   maxDist = 0;
   dfs(farthestNode, 0, n);

   return maxDist;
}

int main() {
   int n, m;
   cout << "Enter the number of vertices and edges: ";
   cin >> n >> m;

   memset(graph, 0, sizeof(graph));

   cout << "Enter the edges (u v) for the undirected graph:\n";
   for (int i = 0; i < m; ++i) {
      int u, v;
      cin >> u >> v;
      graph[u][v] = graph[v][u] = 1;
   }

   cout << "The diameter of the graph is: " << findDiameterDFS(n) << endl;

   return 0;
}
```


Output
Clear
Enter the number of vertices and edges: 5 4
Enter the edges (u v) for the undirected graph:
1 2
3 4
5 6
7 8
The diameter of the graph is: 0
=== Code Execution Successful ===