DOMAIN WINTER WINNING CAMP

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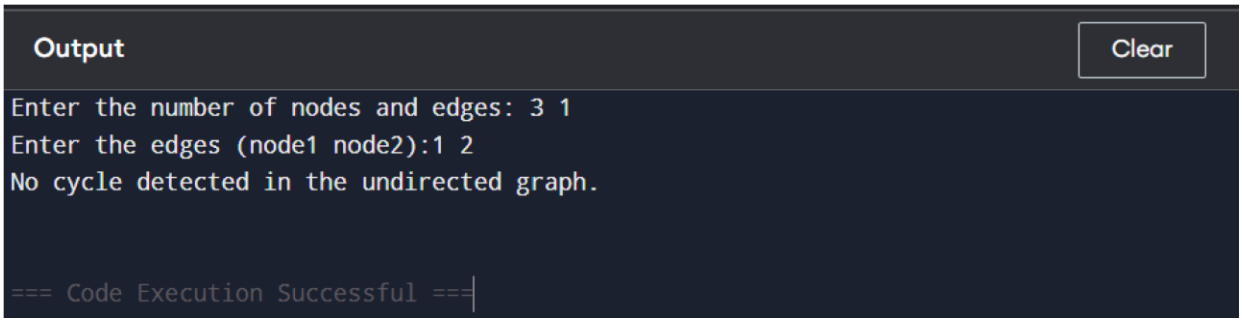
1. Write a program to detect a cycle in the undirected graph

```
#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) {
```

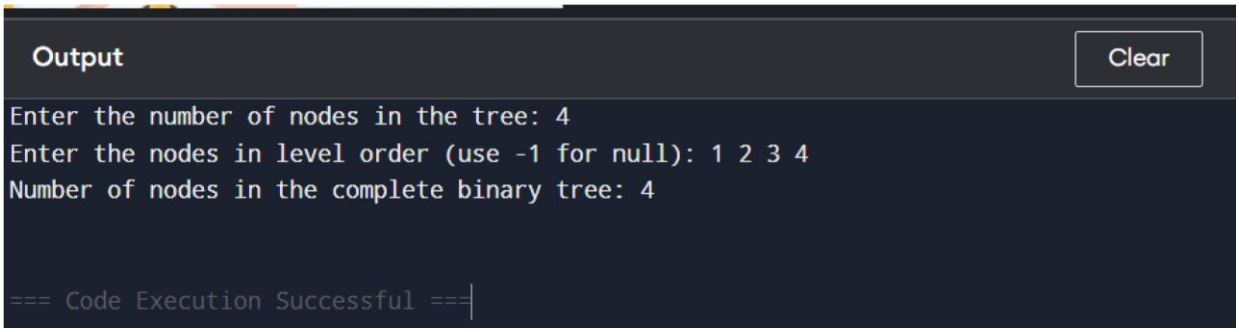
```
        if (adj[node][neighbor]) {
if (!visited[neighbor]) {
                if (dfsCycleDirected(neighbor, n)) {
return true;
                }
            } else if (recStack[neighbor]) {
                return true;
            }
        }
    }
    recStack[node] = false; // Remove the node from 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;  }
```

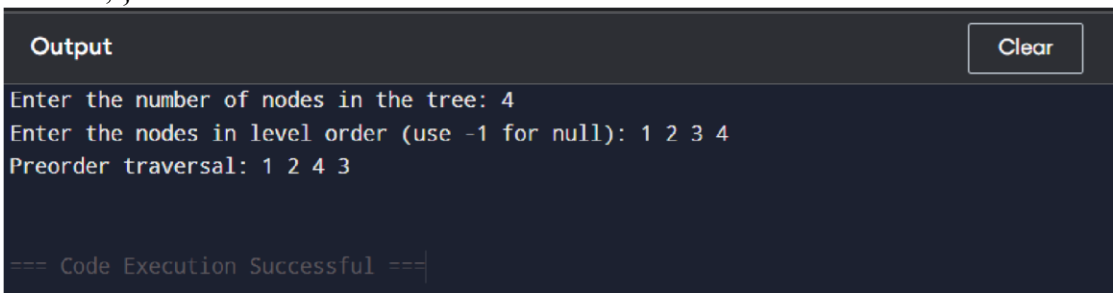
```
int main() {
int n;
   cout << "Enter the number of nodes in the tree: ";
cin >> n;     int arr[n];
   cout << "Enter the nodes in level order (use -1 for null): ";
   for (int i = 0; i < n; ++i) {
      cin >> arr[i];
   }
   TreeNode* root = insertLevelOrder(arr, n, 0);
   cout << "Number of nodes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



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; }
```

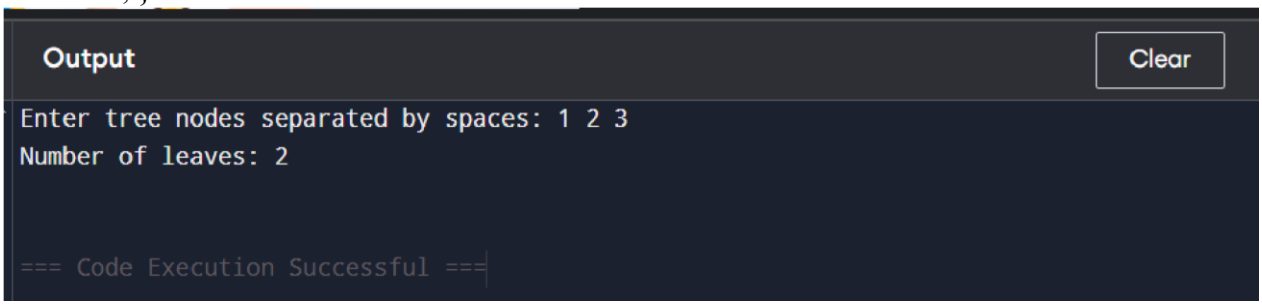
```
Output                                                    Clear
Enter the number of nodes in the tree:3
Enter the nodes in level order (use -1 for null):1 2 -1
DFS traversal: 1 2


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

7. Given a Binary Tree, the task is to count leaves of the tree if both left and right child nodes of it 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;
    }
```

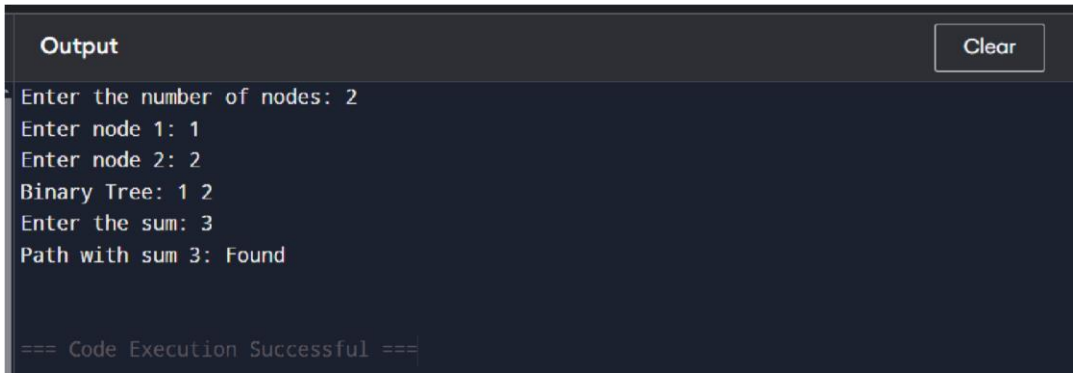
```
    int numLeaves = countLeaves(root);      cout <<
"Number of leaves: " << numLeaves << endl;
deleteTree(root);

    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;
```

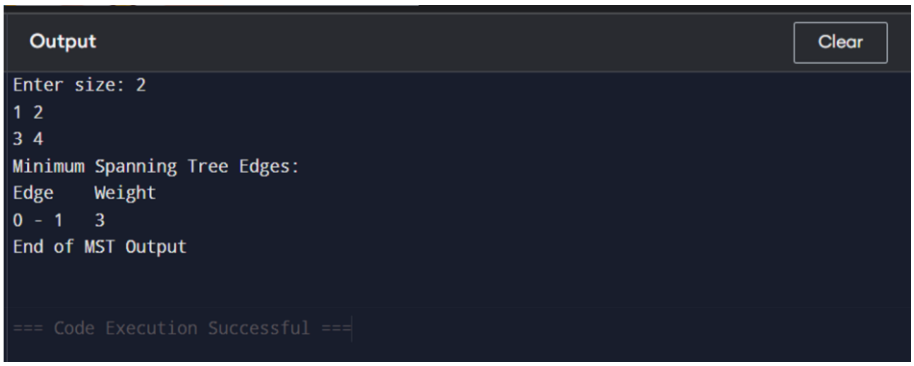
```
    }
    int centerNode = findCenter(n);      cout << "The center of the star
graph is: " << centerNode << endl;

    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) {
```

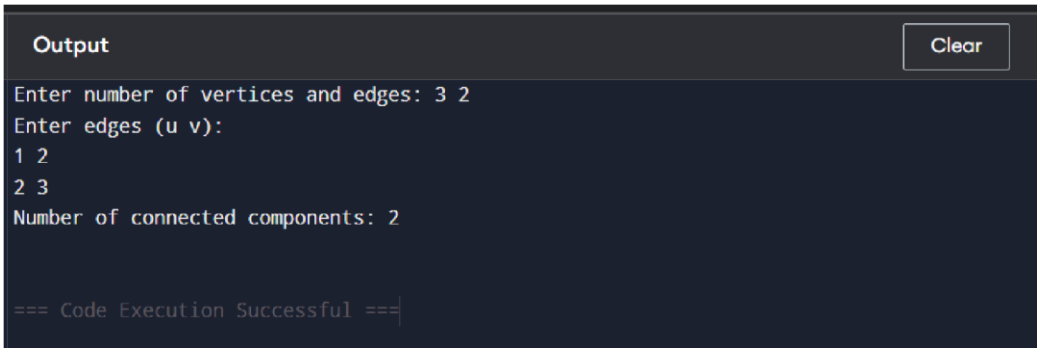
```
            if (graph[min_index][v] && !inMST[v] && graph[min_index][v] < key[v]) {
key[v] = graph[min_index][v];
                parent[v] = min_index;
            }
        }
    }
    cout << "Minimum Spanning Tree Edges:\n";
    cout << "Edge \tWeight\n";
for (int i = 1; i < n; ++i) {
        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

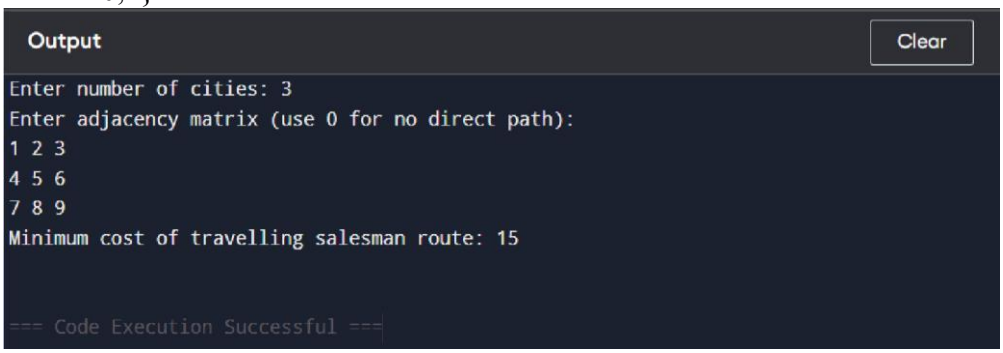
```
#include <iostream> using
namespace std;

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;  }
```

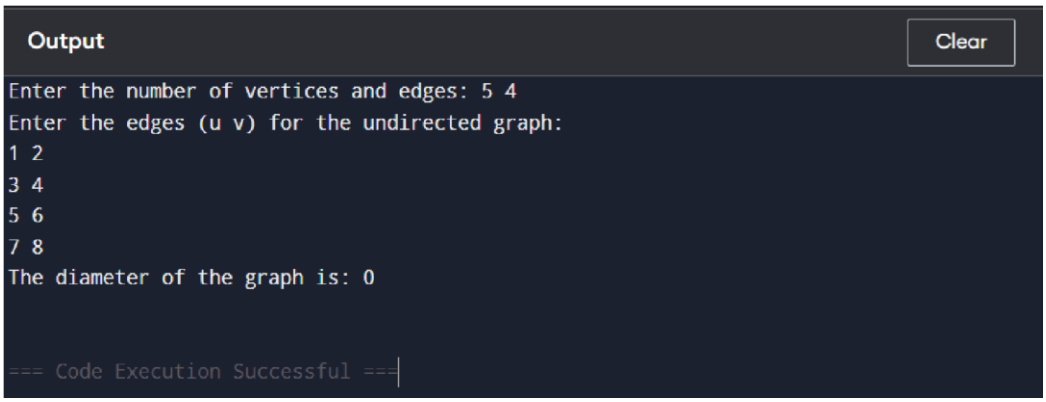


14. Write a program to find the diameter of a undirected graph. Use BFS and DFS

```
#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;
}
```

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COMPUTER SCIENCE & ENGINEERING