DOMAIN WINTER WINNING CAMP

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Semester: 5th
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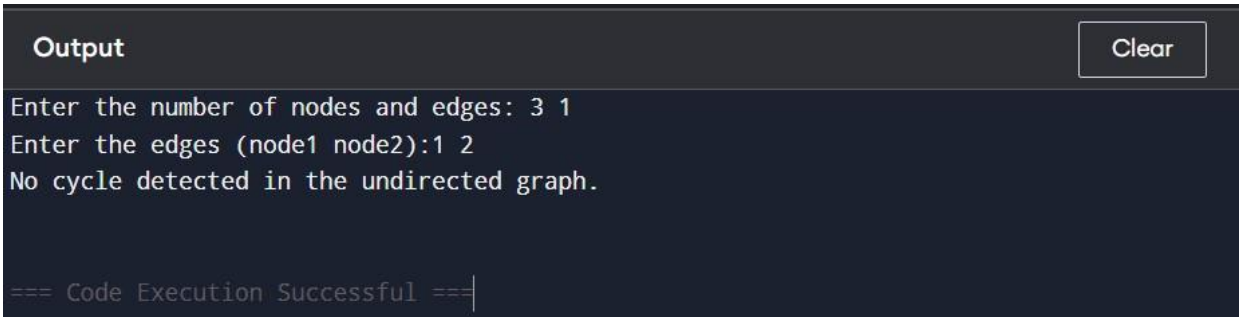
1. Write a program to detect a cycle in the undirected graph

```
#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;
   }
```

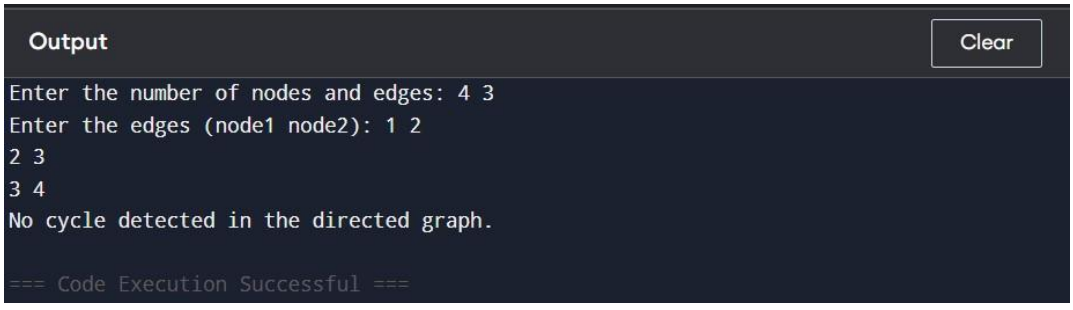
```
    for (int i = 1; i <= n; ++i) {
        visited[i] = false;
    }
    bool hasCycle = false;
for (int i = 1; i <= n; ++i) {
        if (!visited[i]) {
            if (dfsCycleUndirected(i, -1, n)) {
                hasCycle = true;
                break;
            }
        }
    }
    if (hasCycle) {
        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;
```

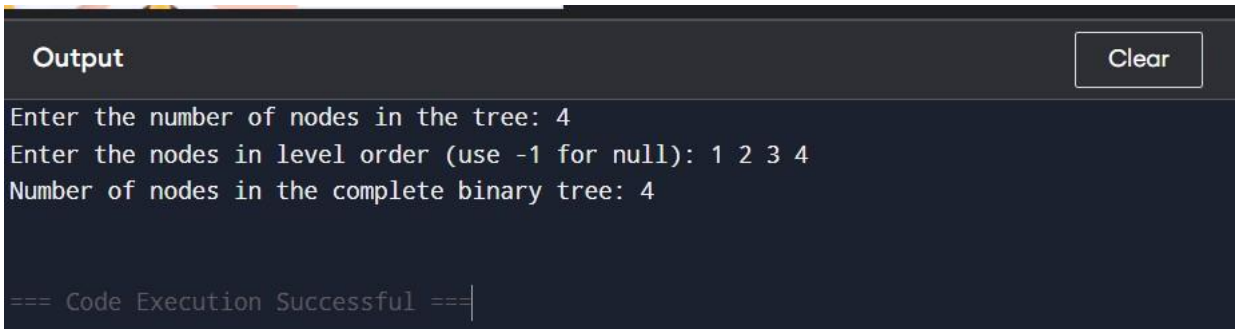
```
            }
        } else if (recStack[neighbor]) {
            return true;
        }
    }
  }
  recStack[node] = false; // Remove the node from recursion stack
return false;
} int main() {
int n, edges;
  cout << "Enter the number of nodes and edges: " << endl;
cin >> n >> edges;

  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; }
```



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];
```

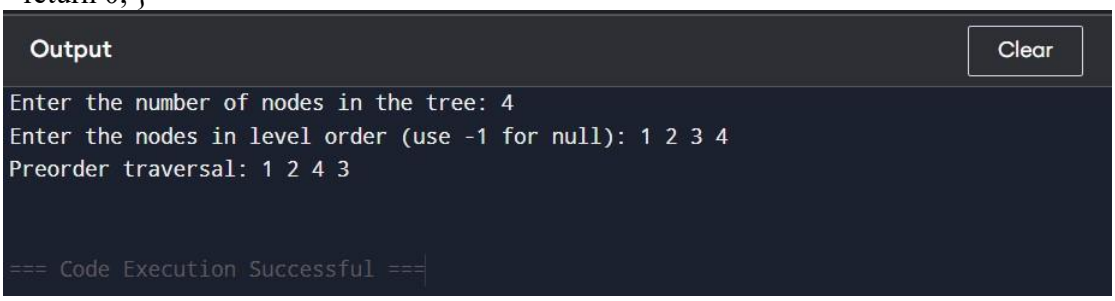
```
    }
    TreeNode* root = insertLevelOrder(arr, n, 0);
    cout << "Number of nodes in the complete binary tree: " << countNodes(root) << endl;

    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;
```

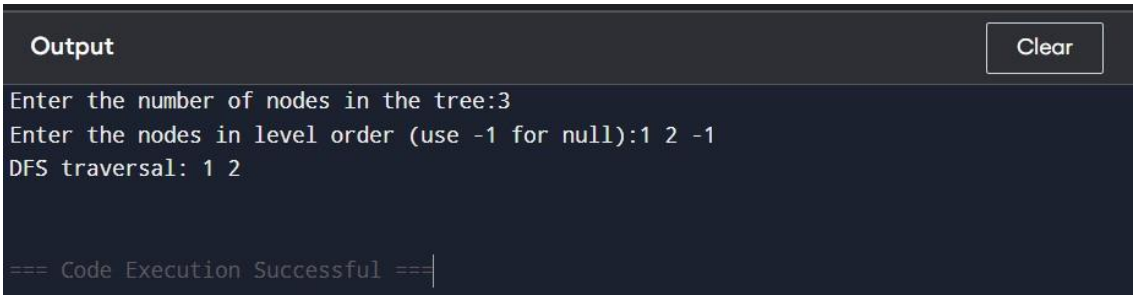
```
    return root->val + sumOfNodes(root->left) + sumOfNodes(root->right);
} int main() {
string input;
    cout << "Enter the tree nodes (comma separated): ";
getline(cin, input);     int index = 0;
    TreeNode* root = buildTree(input, index);
int sum = sumOfNodes(root);
    cout << "Sum of all nodes: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

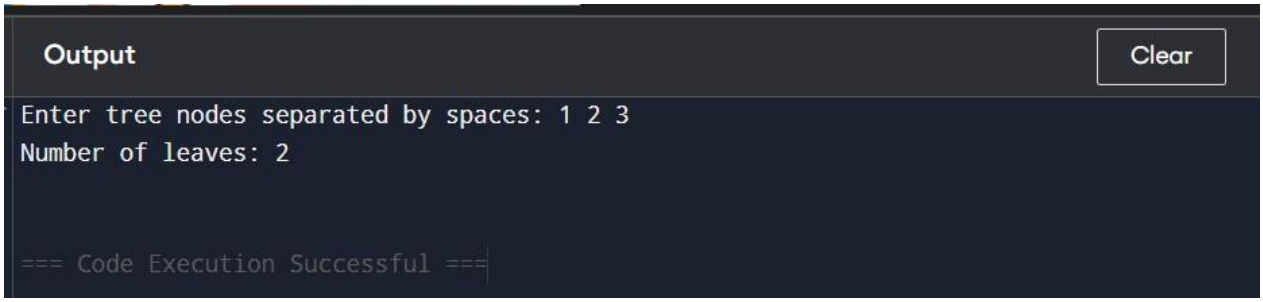
```
    cout << "Enter the nodes in level order (use -1 for null):";
for (int i = 0; i < n; ++i) {         cin >> arr[i];
    }

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



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);
    } }
```

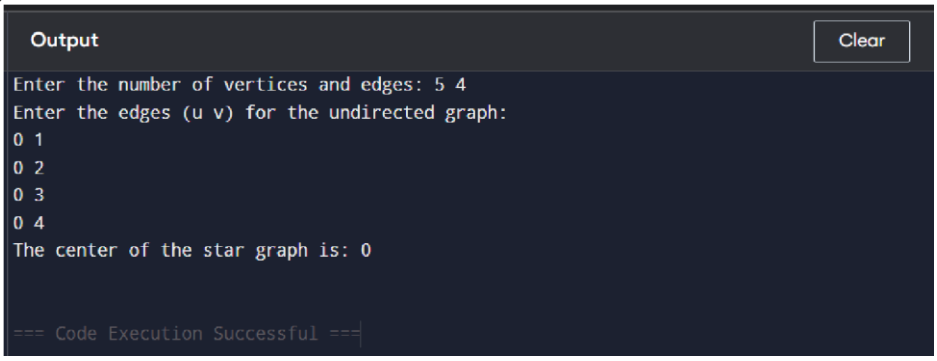
```
void printTree(TreeNode* root) {
if (root == NULL) return;     cout
<< root->val << " ";
printTree(root->left);
printTree(root->right);
} int main() {
Solution solution;
    TreeNode* root = NULL;
    int n;
    cout << "Enter the number of nodes: ";
    cin >> n;
    for (int i = 0; i < n; i++)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

```
Output                                                    Clear
Enter the number of nodes: 2
Enter node 1: 1
Enter node 2: 2
Binary Tree: 1 2
Enter the sum: 3
Path with sum 3: Found


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

9. Find the centre of the star graph

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

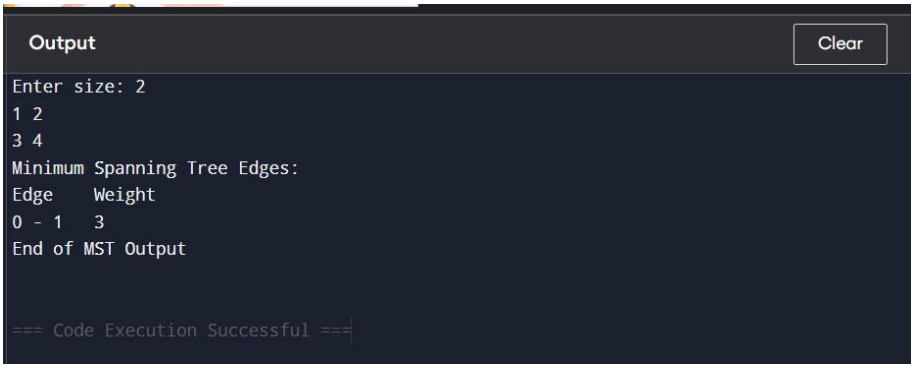
```
const int MAX = 100; int
graph[MAX][MAX];
int findCenter(int n) {
int maxDegree = 0;
   int centerNode = -1;

   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;
}
```



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;
}
```

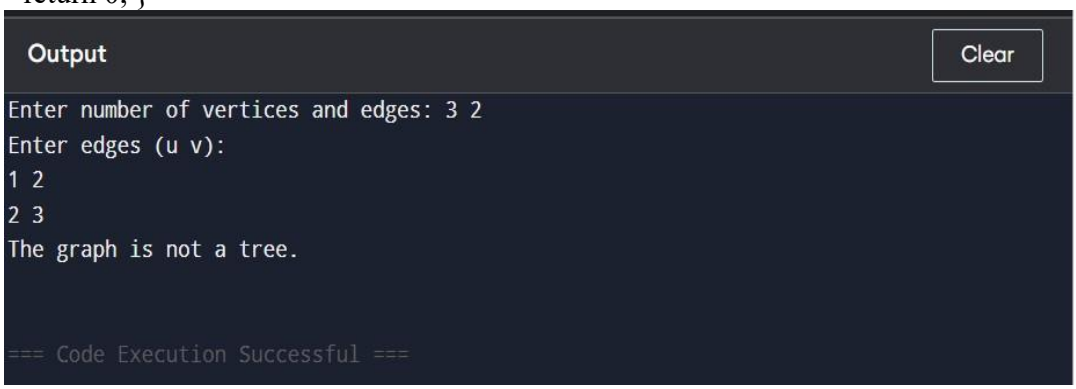
```
int main() {
int n, e;
    cout << "Enter number of vertices and edges: ";
    cin >> n >> e;

    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;
}
```

```
Output                                                    Clear
Enter number of cities: 3
Enter adjacency matrix (use 0 for no direct path):
1 2 3
4 5 6
7 8 9
Minimum cost of travelling salesman route: 15


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

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 ===
```

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COMPUTER SCIENCE & ENGINEERING