Day-7

DOMAIN WINTER WINNING CAMP

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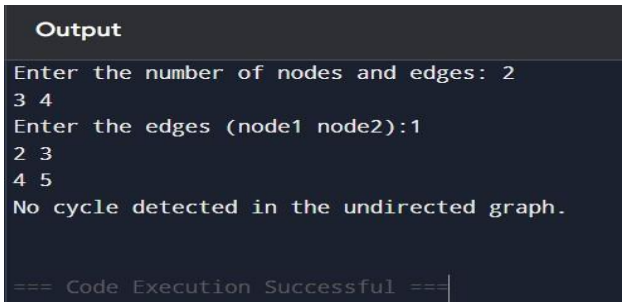
Section : 620-B

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

```
#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;
}
```

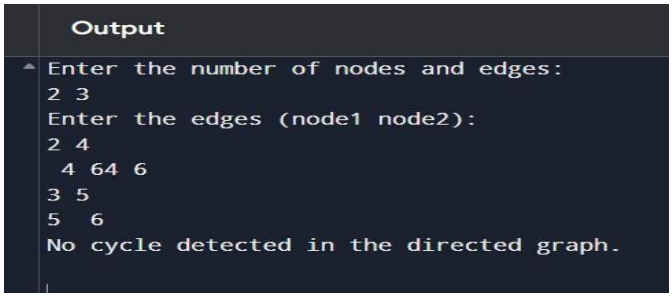
```
int main() {     int n, edges;     cout << "Enter the
number of nodes and edges: ";     cin >> n >>
edges;     cout << "Enter the edges (node1 node2):";
for (int i = 0; i < edges; ++i) {         int u, v;         cin
>> u >> v;
        adj[u][v] = adj[v][u] = 1;
    }
    for (int i = 1; i <= n;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

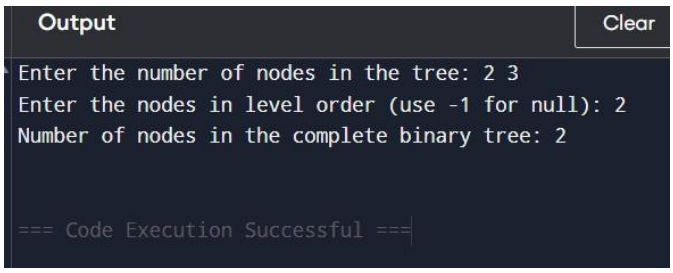
```
    if (hasCycle) {         cout << "Cycle detected in the directed
graph." << endl;
    } else {
        cout << "No cycle detected in the directed graph." << endl;
    }
    return 0;
}
```



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;
}
```

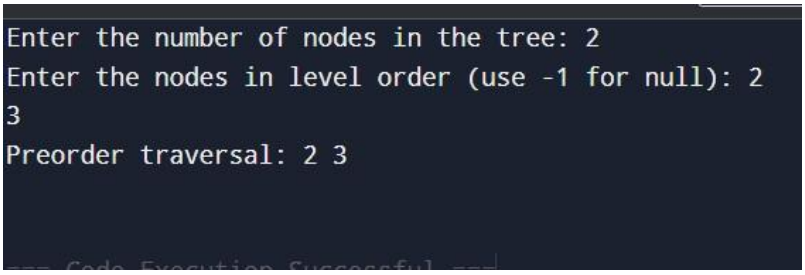
```
int countNodes(TreeNode* root) {
    if (!root) return 0;     int leftHeight = getHeight(root-
>left);     int rightHeight = getHeight(root->right);     if
(leftHeight == rightHeight) {         return (1 <<
leftHeight) + countNodes(root->right);
    } else {
        return (1 << rightHeight) + countNodes(root->left);
    }
}

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;
}
```

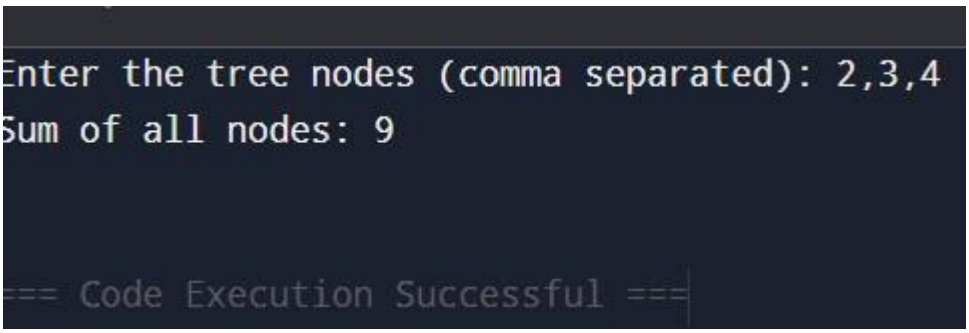
```
int main() {
int n;
    cout << "Enter the number of nodes in the tree: ";     cin
>> n;     int arr[n];     cout << "Enter the nodes in level order
(use -1 for null): ";     for (int i = 0; i < n; ++i) {         cin >>
arr[i];
    }
    TreeNode* root = insertLevelOrder(arr, n, 0);
vector<int> result;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

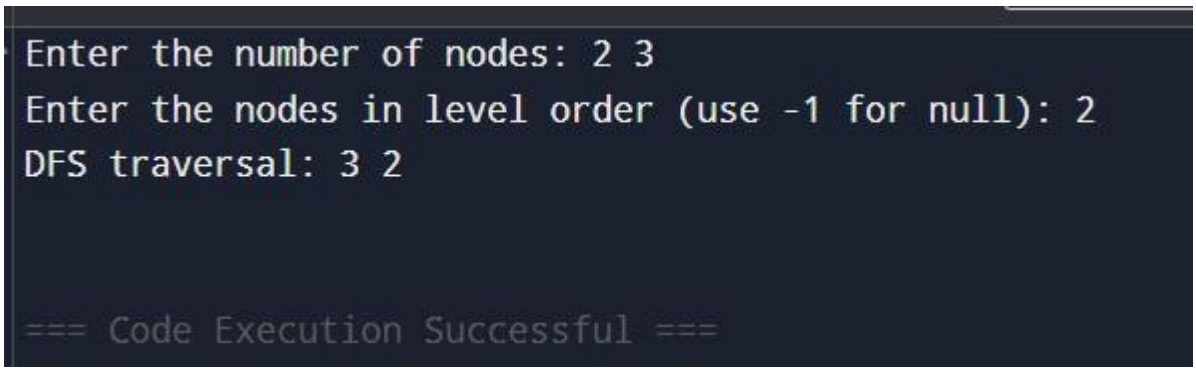
```
#include <iostream>
#include <sstream> using
namespace std;

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;
}
```



6. Implement DFS for a binary tree (continued)

```
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;
}
```

```
Enter the number of nodes and edges: 2
3
Enter the edges (node1 node2):
 4 44 4
4 5 6
2  4 56
Node 1:
Node 2:


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

8. Create a cyclic graph

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

const int MAX_NODES = 100; int
adj[MAX_NODES][MAX_NODES] = {0};

void addEdge(int u, int v) {     adj[u][v]
= 1;     adj[v][u] = 1; // For undirected
graph
}

void printGraph(int n) {     for (int i
= 1; i <= n; ++i) {         cout <<
"Node " << i << ": ";         for (int j
= 1; j <= n; ++j) {             if
(adj[i][j]) {                 cout << j <<
" ";
            }
        }
        cout << endl;
    }
}

int main() {
    int n, edges;
    cout << "Enter the number of nodes and edges: ";
cin >> n >> edges;     cout << "Enter the edges
(node1 node2):" << endl;     for (int i = 0; i < edges;
++i) {         int u, v;         cin >> u >> v;
addEdge(u, v);
    }
```

```
    printGraph(n);
return 0;
}
```

9. Find the centre of the star graph

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

const int MAX_NODES = 100; int
adj[MAX_NODES][MAX_NODES] = {0};

int findCenter(int n) {     int
maxDegree = 0;     int
centerNode = -1;     for (int i =
1; i <= n; ++i) {         int
degree = 0;         for (int j = 1; j
<= n; ++j) {             if (adj[i][j])
degree++;
        }
        if (degree > maxDegree) {
maxDegree = degree;             centerNode
= i;
        }
    }
    return centerNode;
}

int main() {     int n, edges;     cout << "Enter the
number of nodes and edges: ";     cin >> n >> edges;
cout << "Enter the edges (node1 node2):" << endl;
for (int i = 0; i < edges; ++i) {         int u, v;         cin
>> u >> v;
```

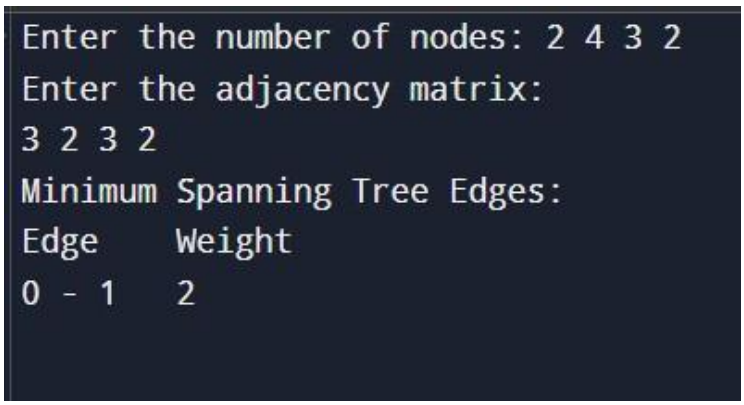
```
        adj[u][v] = adj[v][u] = 1;
    }
    int centerNode = findCenter(n);     cout << "The center of the star
graph is: " << centerNode << endl;     return 0;
}
```

```
Enter the number of nodes and edges: 2 3 4 2
Enter the edges (node1 node2):
2  3 2 2
The center of the star graph is: 2
```

10. Write a program to find minimum spanning tree.

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

const int MAX_NODES = 100; int
graph[MAX_NODES][MAX_NODES];

void primMST(int n) {
int key[n];     bool
inMST[n];     int
parent[n];
    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;         for (int v = 0; v < n; ++v) {
if (!inMST[v] && key[v] < minKey) {
minKey = key[v];                 min_index = v;
```

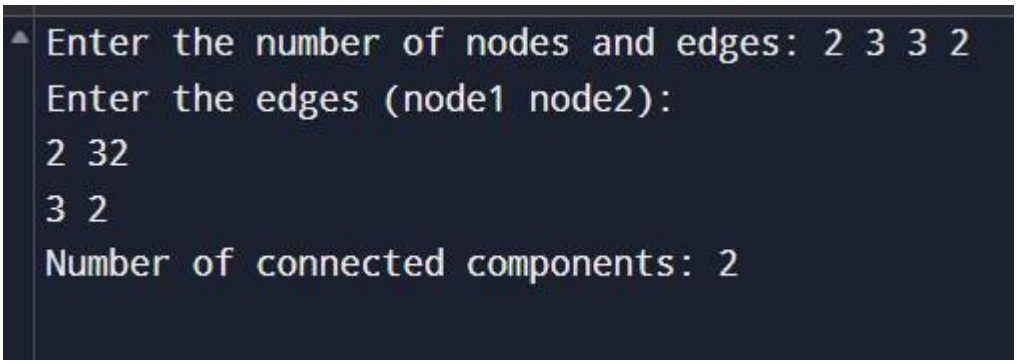
```
            }
        }
        inMST[min_index] = true;         for (int v = 0; v < n; ++v) {
if (graph[min_index][v] && !inMST[v] && graph[min_index][v] <
key[v]) {                 key[v] = graph[min_index][v];                 parent[v] =
min_index;
            }
        }
    }
    cout << "Minimum 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";
    }
}

int main() {
int n;
    cout << "Enter the number of nodes: ";
cin >> n;     cout << "Enter the adjacency
matrix:\n";
    for (int i = 0; i < n; ++i) {
        for (int j = 0; j < n; ++j) {
cin >> graph[i][j];
        }
    }
    primMST(n);
return 0;
}
```



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

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

const int MAX_NODES = 100; int
graph[MAX_NODES][MAX_NODES] = {0};
bool visited[MAX_NODES];

void dfs(int node, int n) {     visited[node] = true;     for
(int neighbor = 1; neighbor <= n; ++neighbor) {
if (graph[node][neighbor] && !visited[neighbor]) {
dfs(neighbor, n);
      }
   }
}

int countConnectedComponents(int n) {
int count = 0;
   for (int i = 1; i <= n; ++i) {
if (!visited[i]) {            dfs(i,
n);            count++;
      }
   }
   return count;
```

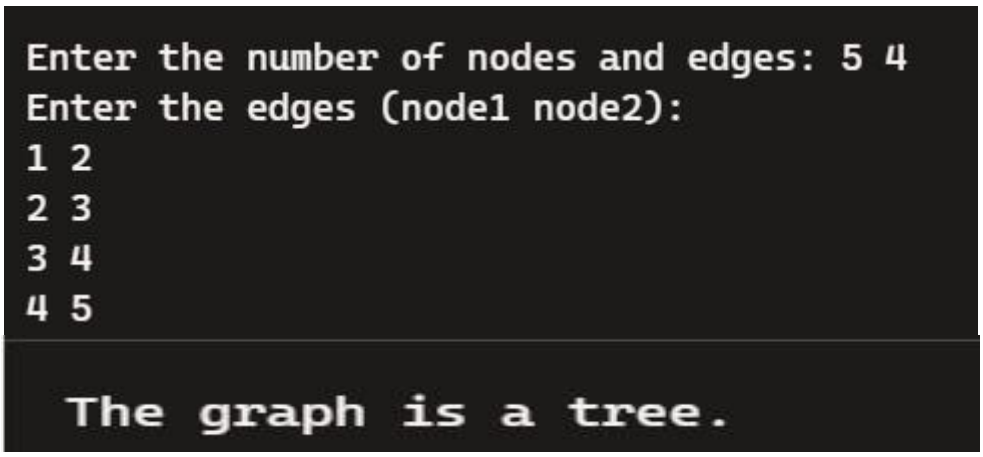
```
}

int main() {     int n, edges;     cout << "Enter the
number of nodes and edges: ";     cin >> n >> edges;
cout << "Enter the edges (node1 node2):" << endl;
for (int i = 0; i < edges; ++i) {         int u, v;         cin
>> u >> v;         graph[u][v] = graph[v][u] = 1;
   }
   cout << "Number of connected components: " <<
countConnectedComponents(n) << endl;
   return 0;
}
```



12. Write a program to check if the graph is a tree or not (continued)

```
bool isConnected(int n) {
   for (int i = 1; i <= n; ++i) visited[i] = false;
dfs(1, n);     for (int i = 1; i <= n; ++i) {
if (!visited[i]) return false;
   }
   return true;
}

bool hasCycle(int node, int parent, int n) {
visited[node] = true;     for (int neighbor = 1; neighbor
<= n; ++neighbor) {         if (graph[node][neighbor]) {
```

```
if (!visited[neighbor]) {                if
(hasCycle(neighbor, node, n)) return true;
            } else if (neighbor != parent) {
return true;
            }
        }
    }
    return false;
}

bool isTree(int n, int edges) {     if (edges !=
n - 1) return false;     if (!isConnected(n))
return false;     for (int i = 1; i <= n; ++i)
visited[i] = false;     if (hasCycle(1, -1, n))
return false;     return true;
}

int main() {     int n, edges;     cout << "Enter the
number of nodes and edges: ";     cin >> n >> edges;
cout << "Enter the edges (node1 node2):" << endl;
for (int i = 0; i < edges; ++i) {
        int u, v;
        cin >> u >> v;
graph[u][v] = graph[v][u] = 1;
    }
    if (isTree(n, edges)) {         cout << "The
graph is a tree." << endl;
    } else {         cout << "The graph is not a
tree." << endl;
    }
    return 0;
}
```



13. Write a program to solve the 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):" << endl;     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 an 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:" << endl;
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;
}
```