PRACTICAL I

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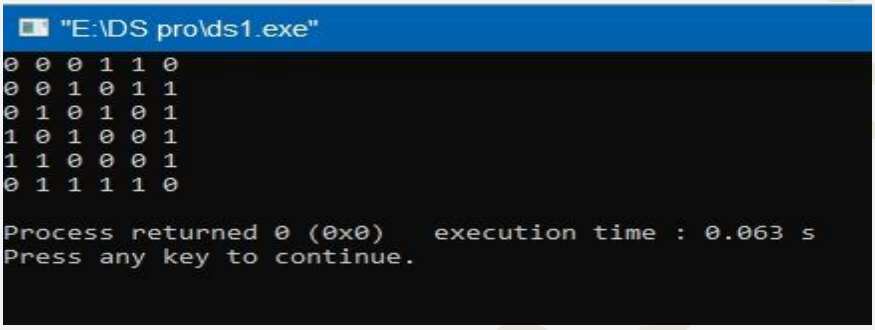
Q1. Write a Program to represent Graphs using the Adjacency matrix and check if it is a complete graph.

PROGRAM:

```
#include<iostream>
using namespace std;
int vertArr[20][20];
int count = 0;
void displayMatrix(int v) {
 int i, j;
 for(i = 0; i < v; i++) {
     for(j = 0; j < v; j++) {
          cout << vertArr[i][j] << " ";
  }
  cout << endl;
 }
}
void add_edge(int u, int v) {
vertArr[v][u] = 1;
vertArr[u][v] = 1;
}
main(int argc, char* argv[]) {
int v = 6;
add_edge(0, 4);
add_edge(0, 3);
add_edge(1, 2);
```

```
add_edge(1, 4);

add_edge(1, 5);

add_edge(2, 3);

add_edge(2, 5);

add_edge(5, 3);

add_edge(5, 4);

displayMatrix(v);

}
```

Output:



Q 2. WAP to accept a directed graph and compute in-degree and out-degree of each vertex.

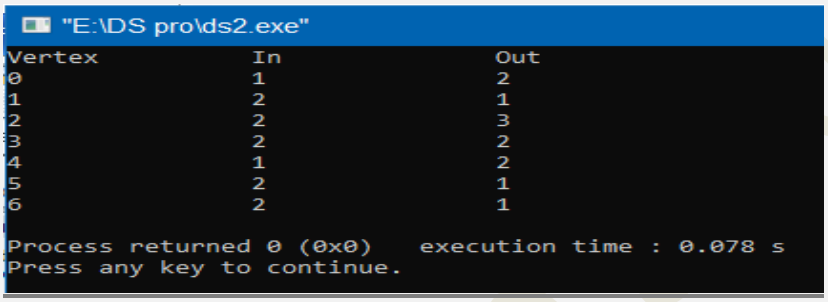
PROGRAM:

```
#include <bits/stdc++.h>
using namespace std; // Function to print the in and out degrees
// of all the vertices of the given graph
void findInOutDegree(list < list < int >> adjlist,
 int n) {
 int * iN = new int[n]();
 int * ouT = new int[n]();
 list < list < int > > ::iterator nest_list;
 int i = 0;
 for (nest_list = adjlist.begin(); nest_list != adjlist.end(); nest_list++) {
  list < int > lst = * nest_list;
  // Out degree for ith vertex will be the count
  // of direct paths from i to other vertices
  ouT[i] = lst.size();
  for (auto it = lst.begin(); it != lst.end(); it++) {
```

```
      // Every vertex that has an incoming
      // edge from i
      iN[ * it]++;
    }
    i++;
  }
  cout << "Vertex\t\tIn\t\tOut" << endl;
  for (int k = 0; k < n; k++) {
    cout << k << "\t\t" <<
      iN[k] << "\t\t" <<
      ouT[k] << endl;
  }
}
// Driver code
int main() {
    // Adjacency list representation of the graph
    list < list < int >> adjlist;
    // Vertices 1 and 2 have an incoming edge
    list < int > tmp;
    tmp.push_back(1);
    tmp.push_back(2);
    adjlist.push_back(tmp);
    tmp.clear();
    // Vertex 3 has an incoming edge
    // from vertex 1
    tmp.push_back(3);
    adjlist.push_back(tmp);
    tmp.clear();
    // Vertices 0, 5 and 6 have an incoming
    // edge from vertex 2
    tmp.push_back(0);
    tmp.push_back(5);
    tmp.push_back(6);
    adjlist.push_back(tmp);
    tmp.clear();
    // Vertices 1 and 4 have an incoming
    // edge from vertex 3
    tmp.push_back(1);
    tmp.push_back(4);
    adjlist.push_back(tmp);
    tmp.clear();
    // Vertices 2 and 3 have an incoming
    // edge from vertex 4
    tmp.push_back(2);
    tmp.push_back(3);
    adjlist.push_back(tmp);
```

```
    tmp.clear();
    // Vertices 4 and 6 have an incoming
    // edge from vertex 5tmp.push_back(4);
    tmp.push_back(6);
    adjlist.push_back(tmp);
    tmp.clear();
    // Vertex 5 has an incoming
    // edge from vertex 6
    tmp.push_back(5);
    adjlist.push_back(tmp);
    tmp.clear();
    int n = adjlist.size();
    findInOutDegree(adjlist, n);
}
```

Output:



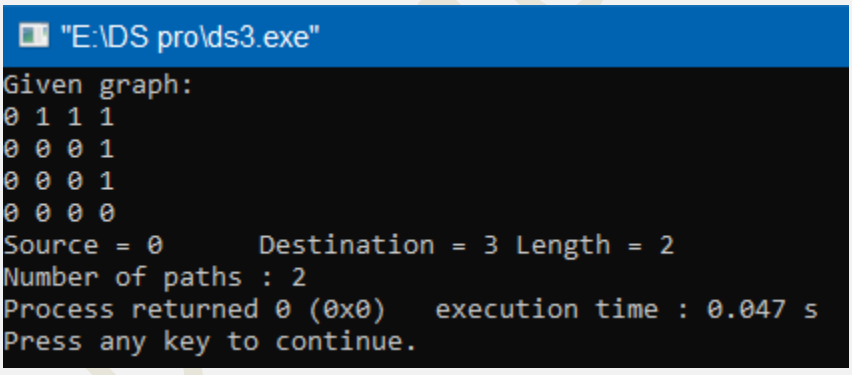
Q 3. Given a graph G, WAP to find the number of paths of length n between source and destination entered by user.

PROGRAM:

```
#include <iostream>
using namespace std;
#define V 4
// A naive recursive function to count
// walks from u to v with k edges
int countwalks(int graph[][V], int u, int v, int k)
{
    if (k == 0 && u == v)
        return 1;
    if (k == 1 && graph[u][v])
        return 1;
    if (k <= 0)
        return 0;
    int count = 0;
    for (int i = 0; i < V; i++)
        if (graph[u][i] == 1) // Check if is adjacent of u
```

```
        count += countwalks(graph, i, v, k - 1);
    return count;
}
void displayMatrix() {

}
int main()
{
    int graph[V][V] = { { 0, 1, 1, 1 },
                        { 0, 0, 0, 1 },
                        { 0, 0, 0, 1 },
                        { 0, 0, 0, 0 } };
    int u = 0, v = 3, n = 2;
    cout<<"Given graph: "<<endl;
    for (int i = 0; i < V; i++) {
      for (int j = 0; j < V; j++) {
        cout << graph[i][j] << " ";
       }
      cout << endl;
    }
    cout<<"Source = " << u<<"\tDestination = "<<v<<"\tLength = "<<n<<endl;
    cout << "Number of paths : " <<countwalks(graph, u, v, n);
    return 0;
}
```

Output:



Q4. Given an adjacency matrix of a graph, write a program to check whether a given set of vertices{v1,v2,v3,.....,vk} forms an Euler path/Euler circuit(for circuit assume vk=v1).

PROGRAM:

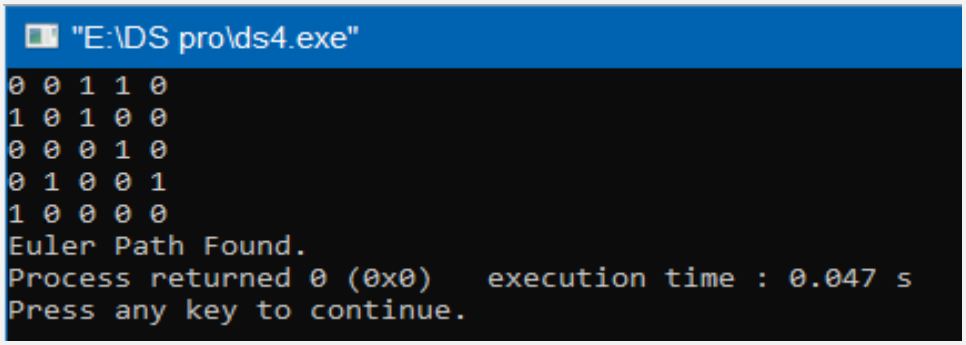
```
#include<iostream>
#include<vector>
#define NODE 5
using namespace std;
```

```
int graph[NODE][NODE] = {
 {0,0,0,0,0},
 {1,0,1,0,0},
 {0,0,0,1,0},
 {0,1,0,0,1},
 {1,0,0,0,0}};
void traverse(int u, bool visited[]) {
 visited[u] = true; //mark v as visited
 for (int v = 0; v < NODE; v++) {
  if (graph[u][v]) {
   if (!visited[v])
    traverse(v, visited);
  }
 }
}
bool isConnected() {
 bool * vis = new bool[NODE];
 //for all vertex u as start point, check whether all nodes are visible or not
 for (int u; u < NODE; u++) {
  for (int i = 0; i < NODE; i++)
   vis[i] = false; //initialize as no node is visited
  traverse(u, vis);
  for (int i = 0; i < NODE; i++) {
   if (!vis[i]) //if there is a node, not visited by traversal, graph is not connected
    return false;
  }
 }
 return true;
}

void displayMatrix() {
 int i, j;
 for (i = 0; i < NODE; i++) {
  for (j = 0; j < NODE; j++) {
   cout << graph[i][j] << " ";
  }
  cout << endl;
 }
}
bool hasEulerPath() {
 int an = 0, bn = 0;
 if (isConnected() == false) { //when graph is not connected
  return false;
 }
 vector < int > inward(NODE, 0), outward(NODE, 0);
 for (int i = 0; i < NODE; i++) {
```

```
   int sum = 0;
   for (int j = 0; j < NODE; j++) {
    if (graph[i][j]) {
      inward[j]++; //increase inward edge for destination vertex
      sum++; //how many outward edge
    }
   }
   outward[i] = sum;
  }
  //check the condition for Euler paths
  if (inward == outward) //when number inward edges and outward edges for each node is
same
   return true; //Euler Circuit, it has Euler path
  for (int i = 0; i < NODE; i++) {
   if (inward[i] != outward[i]) {
    if ((inward[i] + 1 == outward[i])) {
      an++;
    } else if ((inward[i] == outward[i] + 1)) {
      bn++;
    }
   }
  }
  if (an == 1 && bn == 1) { //if there is only an, and bn, then this has euler path
   return true;
  }
  return false;
}
int main() {
   displayMatrix();
  if (hasEulerPath())
   cout << "Euler Path Found.";
  else
   cout << "There is no Euler Path.";
}
```

Output:

```
C:\Users\saumya gupta\AppData\Roaming\Microsoft\Windows\Start Menu\Programs\CodeBloc
0 0 0 0 0
1 0 1 0 0
0 0 0 1 0
0 1 0 0 1
1 0 0 0 0
There is no Euler Path.
Process returned 0 (0x0)   execution time : 0.094 s
Press any key to continue.
```



Q5. Given a full m-ary tree with i internal vertices, WAP to find number of leaf nodes.

PROGRAM:

```
#include <bits/stdc++.h>
using namespace std;
// Function to calculate
// leaf nodes in n-ary tree
int calcNodes(int N, int I) {
  int result = 0;
  result = I * (N - 1) + 1;
  return result;
}
// Driver code
int main() {
  int N = 5, I = 2;
  cout << "Leaf nodes = " << calcNodes(N, I);
  return 0;
}
```

Output:

```
N = 5   I = 2
Leaf nodes = 9
```

```
N = 4   I = 2
Leaf nodes = 7
```