Practical-7

Aim: Implement Hamiltonian Cycle using Backtracking.

Problem Statement:

The Smart City Transportation Department is designing a night-patrol route for
security vehicles.
Each area of the city is represented as a vertex in a graph, and a road between two
areas is represented as an edge.
The goal is to find a route that starts from the main headquarters (Area A), visits
each area exactly once, and returns back to the headquarters — forming a
Hamiltonian Cycle.
If such a route is not possible, display a suitable message.

1) Adjacency Matrix

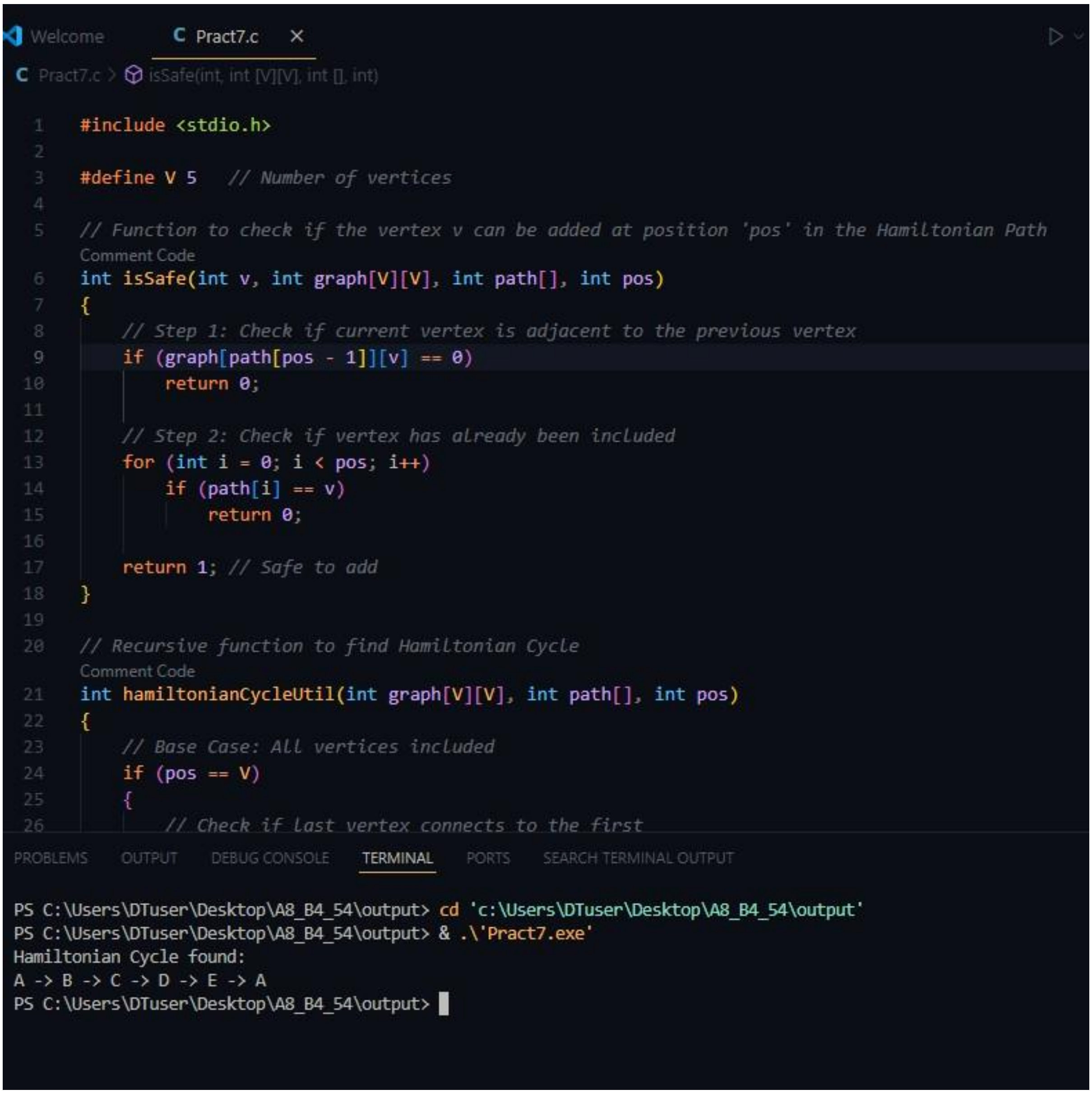
	A	B	C	D	E
A	0	1	1	0	1
B	1	0	1	1	0
C	1	1	0	1	0
D	0	1	1	0	1
E	1	0	0	1	0

Code:

```
#include <stdio.h>

#define V 5   // Number of vertices

// Function to check if the vertex v can be added at position 'pos' in the Hamiltonian Path
int isSafe(int v, int graph[V][V], int path[], int pos)
```

```
{
    // Step 1: Check if current vertex is adjacent to the previous vertex
    if (graph[path[pos - 1]][v] == 0)
        return 0;

    // Step 2: Check if vertex has already been included
    for (int i = 0; i < pos; i++)
        if (path[i] == v)
            return 0;

    return 1; // Safe to add
}

// Recursive function to find Hamiltonian Cycle
int hamiltonianCycleUtil(int graph[V][V], int path[], int pos)
{
    // Base Case: All vertices included
    if (pos == V)
    {
        // Check if last vertex connects to the first
        if (graph[path[pos - 1]][path[0]] == 1)
            return 1;
        else
            return 0;
    }

    // Try different vertices as the next candidate
    for (int v = 1; v < V; v++)
    {
        if (isSafe(v, graph, path, pos))
        {
            path[pos] = v; // Add vertex to path
            // Recur to build rest of path
            if (hamiltonianCycleUtil(graph, path, pos + 1) == 1)
                return 1;

            // Backtrack: remove vertex if it doesn't work
            path[pos] = -1;
        }
    }

    // If no vertex can be added
    return 0;
}

// Function to solve Hamiltonian Cycle problem
void hamiltonianCycle(int graph[V][V])
{
    int path[V];

    // Initialize all vertices as not visited
    for (int i = 0; i < V; i++)
        path[i] = -1;

    // Start at first vertex (T = 0)
    path[0] = 0;

    if (hamiltonianCycleUtil(graph, path, 1) == 0)
    {
        printf("No Hamiltonian Cycle exists\n");
        return;
    }

    // Print the Hamiltonian Cycle
    printf("Hamiltonian Cycle found:\n");
    for (int i = 0; i < V; i++)
        printf("%c -> ", 'A' + path[i]); // Convert 0→T, 1→M, etc.
    printf("%c\n", 'A' + path[0]);
}

int main()
{
    // Adjacency matrix for A,B,C,D,E
    int graph[V][V] = {
        {0, 1, 1, 0, 1},  // A
        {1, 0, 1, 1, 0},  // B
        {1, 1, 0, 1, 0},  // C
        {0, 1, 1, 0, 1},  // D
        {1, 0, 0, 1, 0}   // E
    };

    hamiltonianCycle(graph);

    return 0;
}
```

Output:



```c
#include <stdio.h>

#define V 5   // Number of vertices

// Function to check if the vertex v can be added at position 'pos' in the Hamiltonian Path
int isSafe(int v, int graph[V][V], int path[], int pos)
{
    // Step 1: Check if current vertex is adjacent to the previous vertex
    if (graph[path[pos - 1]][v] == 0)
        return 0;

    // Step 2: Check if vertex has already been included
    for (int i = 0; i < pos; i++)
        if (path[i] == v)
            return 0;

    return 1; // Safe to add
}

// Recursive function to find Hamiltonian Cycle
int hamiltonianCycleUtil(int graph[V][V], int path[], int pos)
{
    // Base Case: All vertices included
    if (pos == V)
    {
        // Check if last vertex connects to the first
```

```
PS C:\Users\DTuser\Desktop\A8_B4_54\output> cd 'c:\Users\DTuser\Desktop\A8_B4_54\output'
PS C:\Users\DTuser\Desktop\A8_B4_54\output> & .\'Pract7.exe'
Hamiltonian Cycle found:
A -> B -> C -> D -> E -> A
PS C:\Users\DTuser\Desktop\A8_B4_54\output>
```