ASSIGNMENT 5

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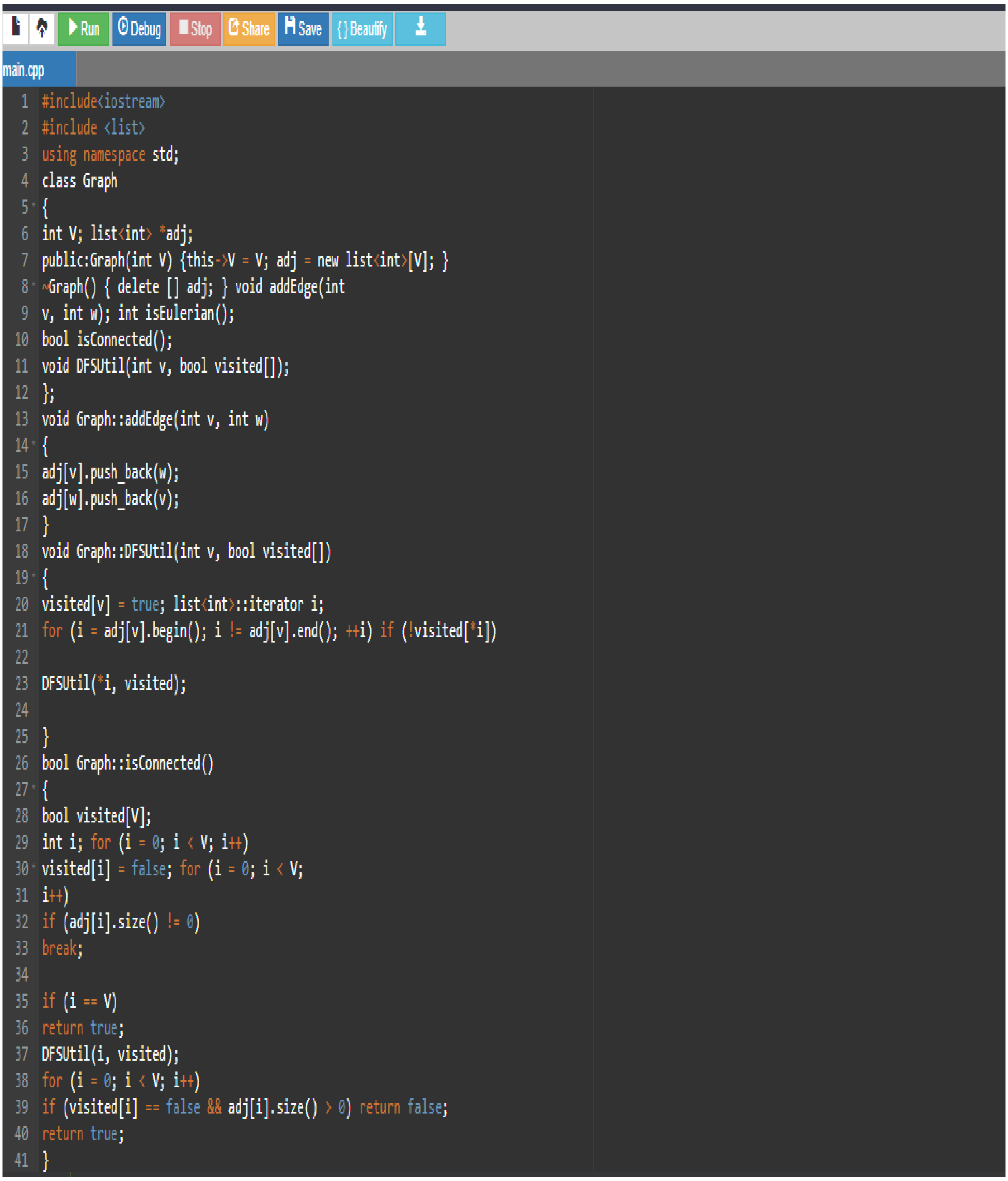
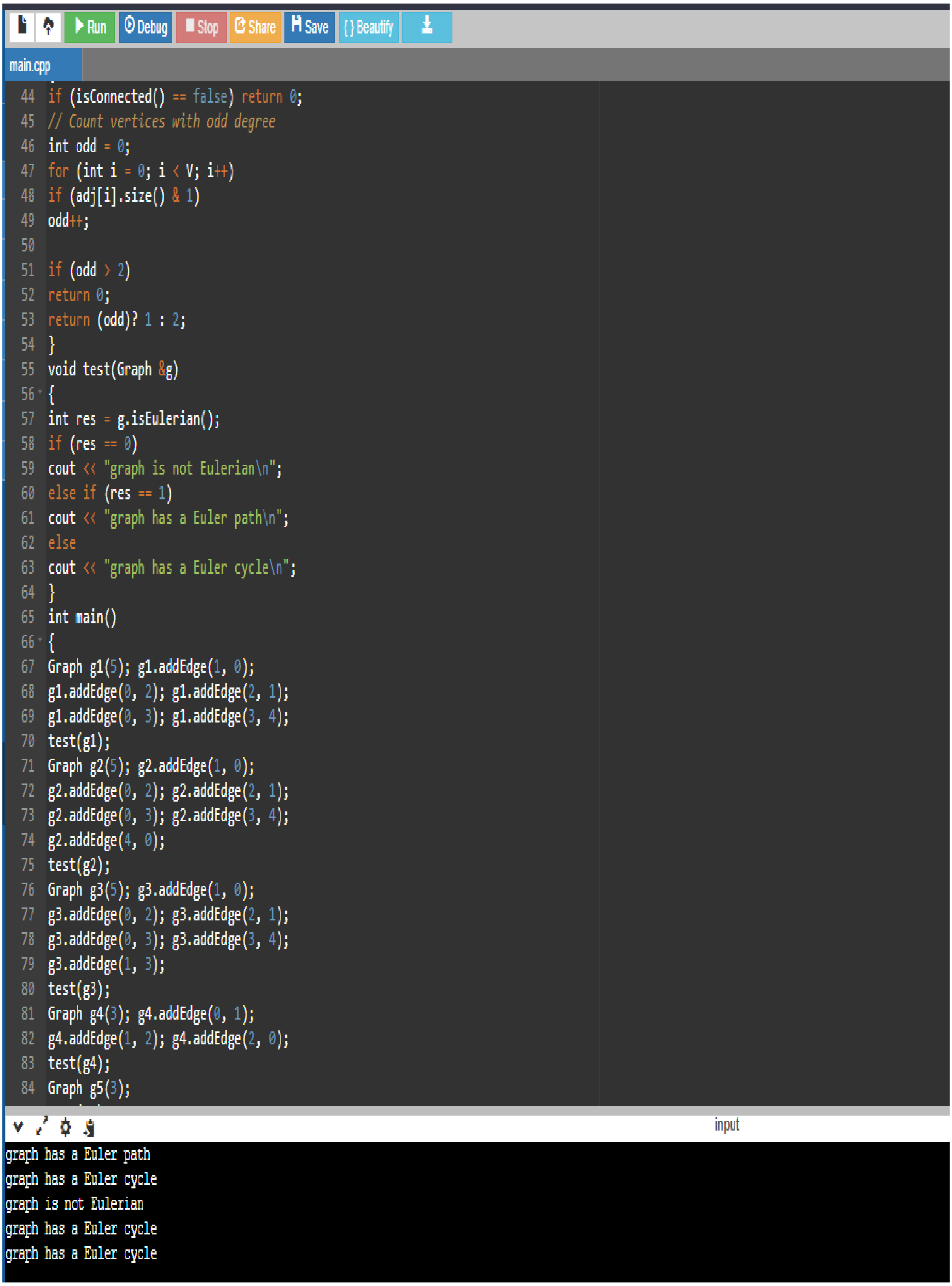
Q1)->FORD FULKERSION



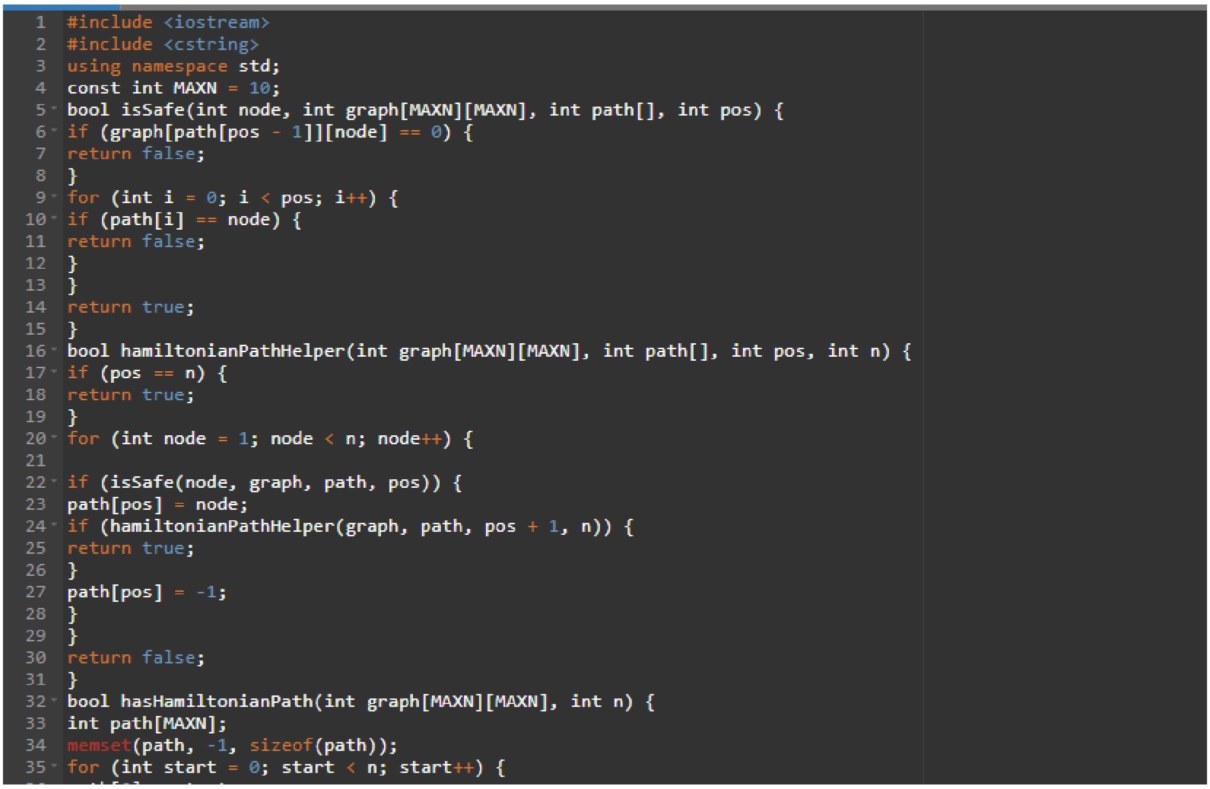
```
#include<iostream>
#include <list>
using namespace std;
class Graph
{
int V; list<int> *adj;
public:Graph(int V) {this->V = V; adj = new list<int>[V]; }
~Graph() { delete [] adj; } void addEdge(int
v, int w); int isEulerian();
bool isConnected();
void DFSUtil(int v, bool visited[]);
};
void Graph::addEdge(int v, int w)
{
adj[v].push_back(w);
adj[w].push_back(v);
}
void Graph::DFSUtil(int v, bool visited[])
{
visited[v] = true; list<int>::iterator i;
for (i = adj[v].begin(); i != adj[v].end(); ++i) if (!visited[*i])

DFSUtil(*i, visited);

}
bool Graph::isConnected()
{
bool visited[V];
int i; for (i = 0; i < V; i++)
visited[i] = false; for (i = 0; i < V;
i++)
if (adj[i].size() != 0)
break;

if (i == V)
return true;
DFSUtil(i, visited);
for (i = 0; i < V; i++)
if (visited[i] == false && adj[i].size() > 0) return false;
return true;
}
```



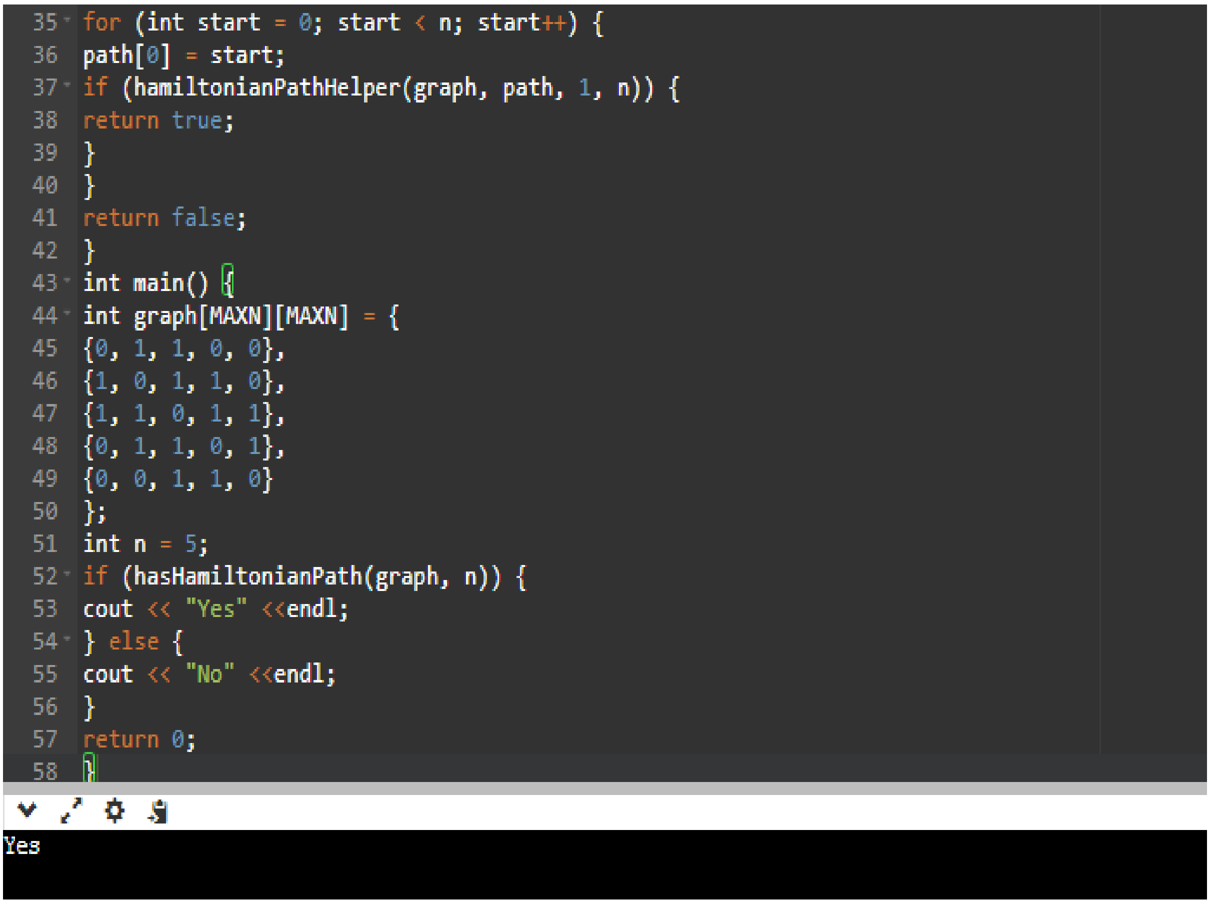
```
if (isConnected() == false) return 0;
// Count vertices with odd degree
int odd = 0;
for (int i = 0; i < V; i++)
if (adj[i].size() & 1)
odd++;

if (odd > 2)
return 0;
return (odd)? 1 : 2;
}
void test(Graph &g)
{
int res = g.isEulerian();
if (res == 0)
cout << "graph is not Eulerian\n";
else if (res == 1)
cout << "graph has a Euler path\n";
else
cout << "graph has a Euler cycle\n";
}
int main()
{
Graph g1(5); g1.addEdge(1, 0);
g1.addEdge(0, 2); g1.addEdge(2, 1);
g1.addEdge(0, 3); g1.addEdge(3, 4);
test(g1);
Graph g2(5); g2.addEdge(1, 0);
g2.addEdge(0, 2); g2.addEdge(2, 1);
g2.addEdge(0, 3); g2.addEdge(3, 4);
g2.addEdge(4, 0);
test(g2);
Graph g3(5); g3.addEdge(1, 0);
g3.addEdge(0, 2); g3.addEdge(2, 1);
g3.addEdge(0, 3); g3.addEdge(3, 4);
g3.addEdge(1, 3);
test(g3);
Graph g4(3); g4.addEdge(0, 1);
g4.addEdge(1, 2); g4.addEdge(2, 0);
test(g4);
Graph g5(3);
```

```
graph has a Euler path
graph has a Euler cycle
graph is not Eulerian
graph has a Euler cycle
graph has a Euler cycle
```

Q2)Hamiltonian graph?



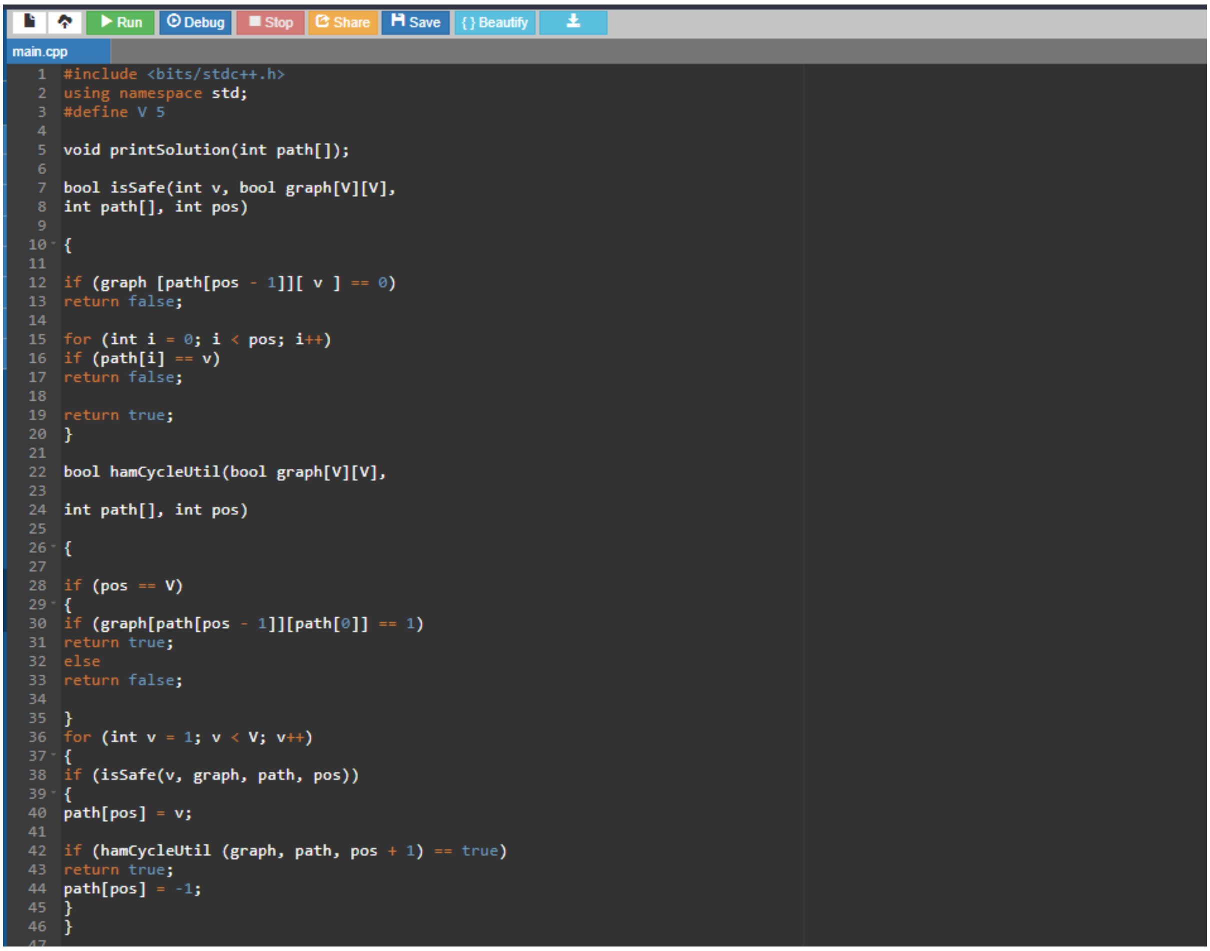
```
#include <iostream>
#include <cstring>
using namespace std;
const int MAXN = 10;
bool isSafe(int node, int graph[MAXN][MAXN], int path[], int pos) {
if (graph[path[pos - 1]][node] == 0) {
return false;
}
for (int i = 0; i < pos; i++) {
if (path[i] == node) {
return false;
}
}
return true;
}
bool hamiltonianPathHelper(int graph[MAXN][MAXN], int path[], int pos, int n) {
if (pos == n) {
return true;
}
for (int node = 1; node < n; node++) {

if (isSafe(node, graph, path, pos)) {
path[pos] = node;
if (hamiltonianPathHelper(graph, path, pos + 1, n)) {
return true;
}
path[pos] = -1;
}
}
return false;
}
bool hasHamiltonianPath(int graph[MAXN][MAXN], int n) {
int path[MAXN];
memset(path, -1, sizeof(path));
for (int start = 0; start < n; start++) {
```



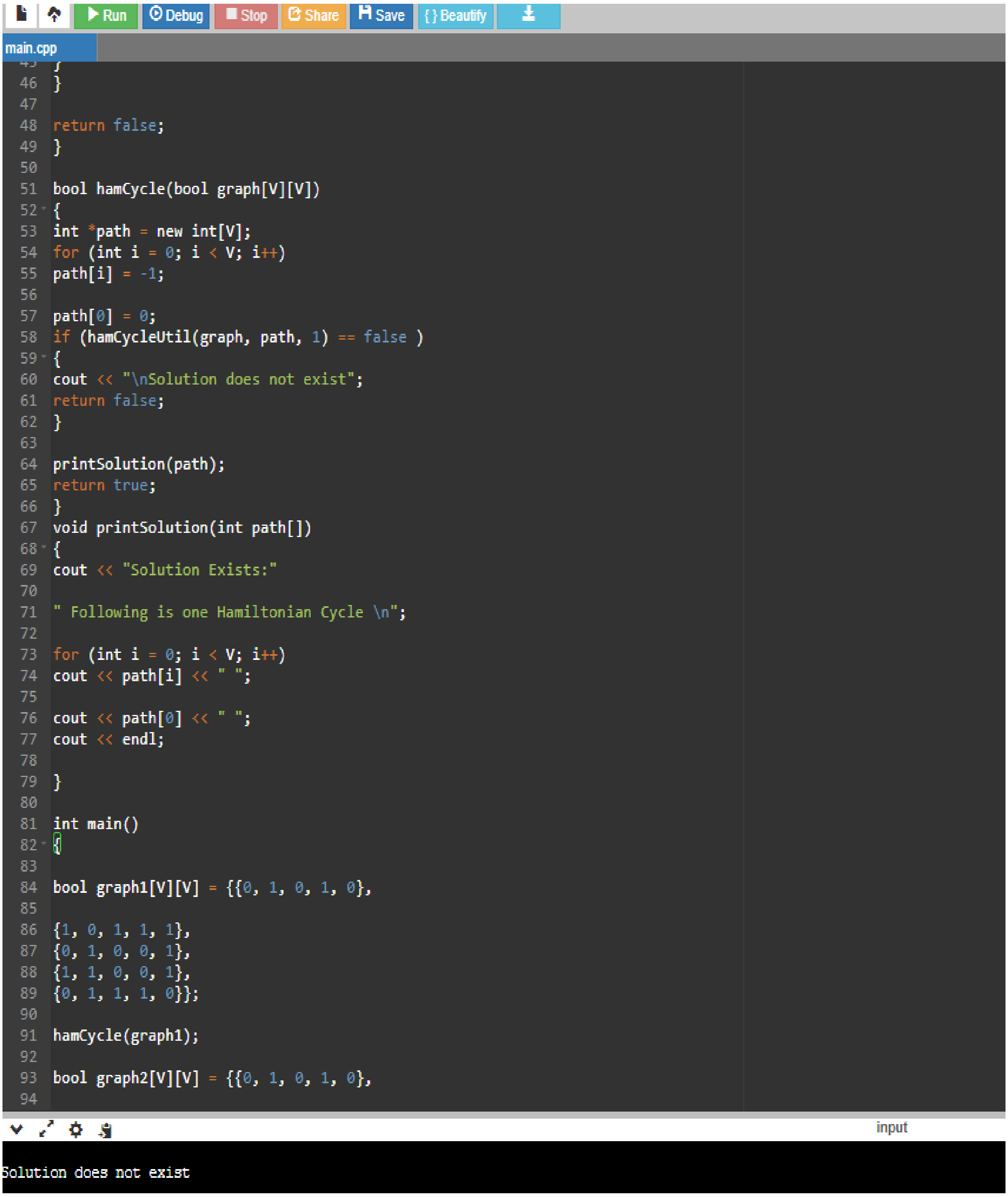
```
for (int start = 0; start < n; start++) {
path[0] = start;
if (hamiltonianPathHelper(graph, path, 1, n)) {
return true;
}
}
return false;
}
int main() {
int graph[MAXN][MAXN] = {
{0, 1, 1, 0, 0},
{1, 0, 1, 1, 0},
{1, 1, 0, 1, 1},
{0, 1, 1, 0, 1},
{0, 0, 1, 1, 0}
};
int n = 5;
if (hasHamiltonianPath(graph, n)) {
cout << "Yes" <<endl;
} else {
cout << "No" <<endl;
}
return 0;
}
```

```
Yes
```

Q3) Write a program for finding the Hamiltonian Cycle or Hamiltonian Circuit in a graph using backtracking?



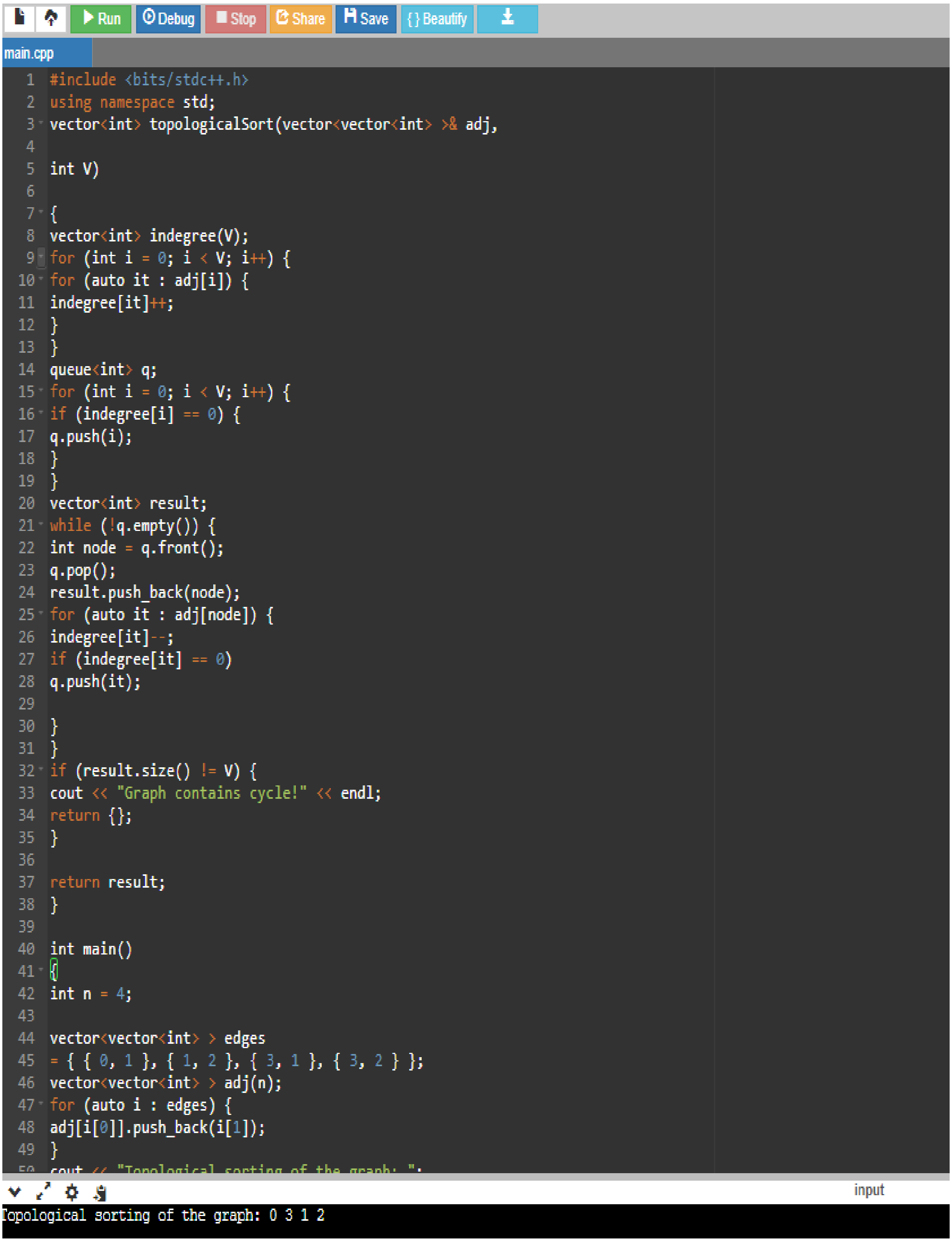
```cpp
#include <bits/stdc++.h>
using namespace std;
#define V 5

void printSolution(int path[]);

bool isSafe(int v, bool graph[V][V],
int path[], int pos)

{

if (graph [path[pos - 1]][ v ] == 0)
return false;

for (int i = 0; i < pos; i++)
if (path[i] == v)
return false;

return true;
}

bool hamCycleUtil(bool graph[V][V],

int path[], int pos)

{

if (pos == V)
{
if (graph[path[pos - 1]][path[0]] == 1)
return true;
else
return false;

}
for (int v = 1; v < V; v++)
{
if (isSafe(v, graph, path, pos))
{
path[pos] = v;

if (hamCycleUtil (graph, path, pos + 1) == true)
return true;
path[pos] = -1;
}
}
```



```
}
}

return false;
}

bool hamCycle(bool graph[V][V])
{
int *path = new int[V];
for (int i = 0; i < V; i++)
path[i] = -1;

path[0] = 0;
if (hamCycleUtil(graph, path, 1) == false )
{
cout << "\nSolution does not exist";
return false;
}

printSolution(path);
return true;
}
void printSolution(int path[])
{
cout << "Solution Exists:"

" Following is one Hamiltonian Cycle \n";

for (int i = 0; i < V; i++)
cout << path[i] << " ";

cout << path[0] << " ";
cout << endl;

}

int main()
{

bool graph1[V][V] = {{0, 1, 0, 1, 0},

{1, 0, 1, 1, 1},
{0, 1, 0, 0, 1},
{1, 1, 0, 0, 1},
{0, 1, 1, 1, 0}};

hamCycle(graph1);

bool graph2[V][V] = {{0, 1, 0, 1, 0},

```

```
Solution does not exist
```

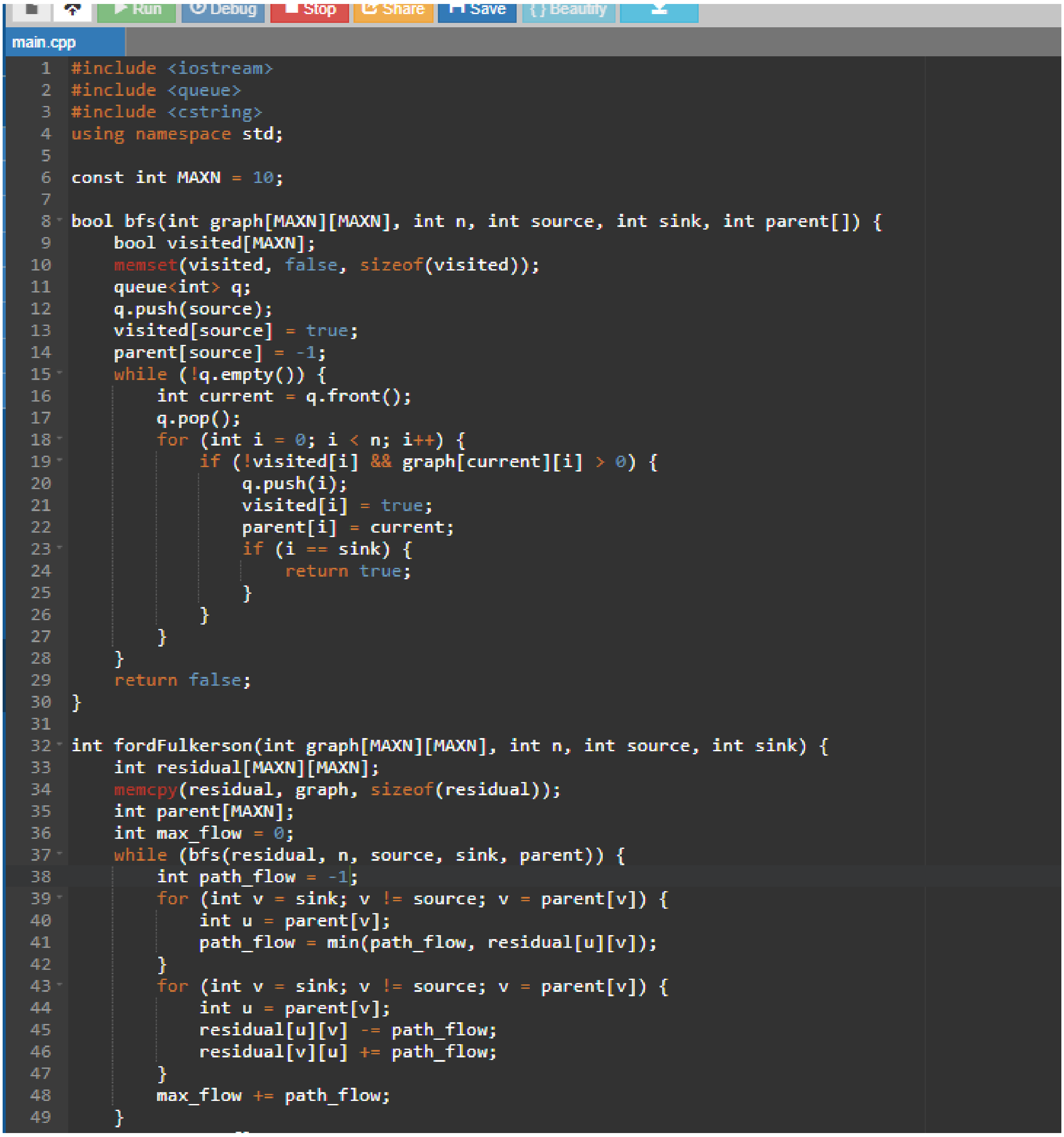
Q4)Topological sort using Kahn algo and DFS?



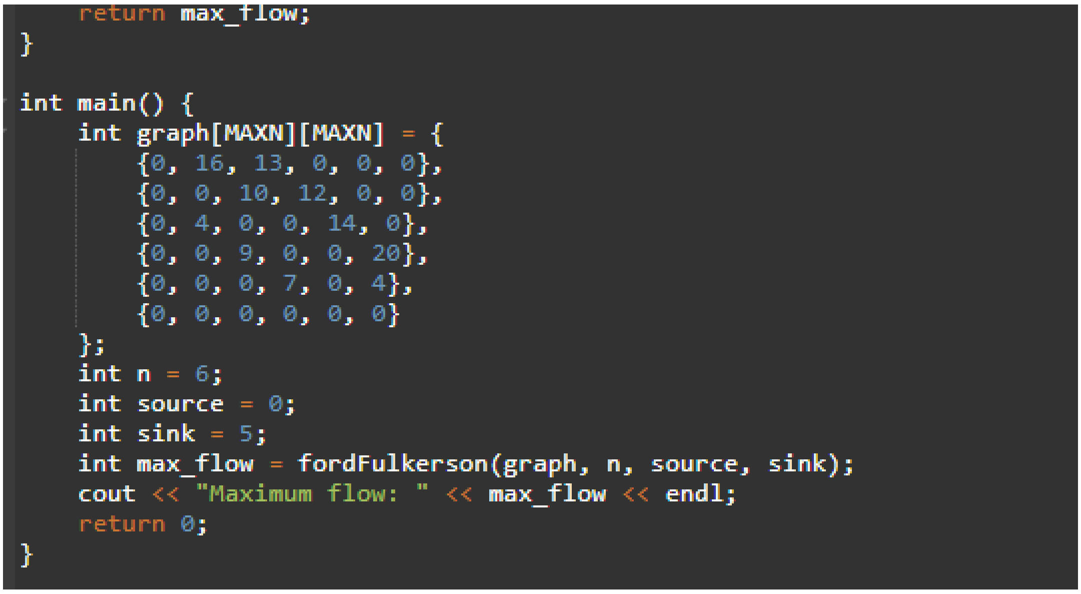
```cpp
#include <bits/stdc++.h>
using namespace std;
vector<int> topologicalSort(vector<vector<int> >& adj,

int V)

{
vector<int> indegree(V);
for (int i = 0; i < V; i++) {
for (auto it : adj[i]) {
indegree[it]++;
}
}
queue<int> q;
for (int i = 0; i < V; i++) {
if (indegree[i] == 0) {
q.push(i);
}
}
vector<int> result;
while (!q.empty()) {
int node = q.front();
q.pop();
result.push_back(node);
for (auto it : adj[node]) {
indegree[it]--;
if (indegree[it] == 0)
q.push(it);

}
}
if (result.size() != V) {
cout << "Graph contains cycle!" << endl;
return {};
}

return result;
}

int main()
{
int n = 4;

vector<vector<int> > edges
= { { 0, 1 }, { 1, 2 }, { 3, 1 }, { 3, 2 } };
vector<vector<int> > adj(n);
for (auto i : edges) {
adj[i[0]].push_back(i[1]);
}
cout << "Topological sorting of the graph: ";
```

```
Topological sorting of the graph: 0 3 1 2
```

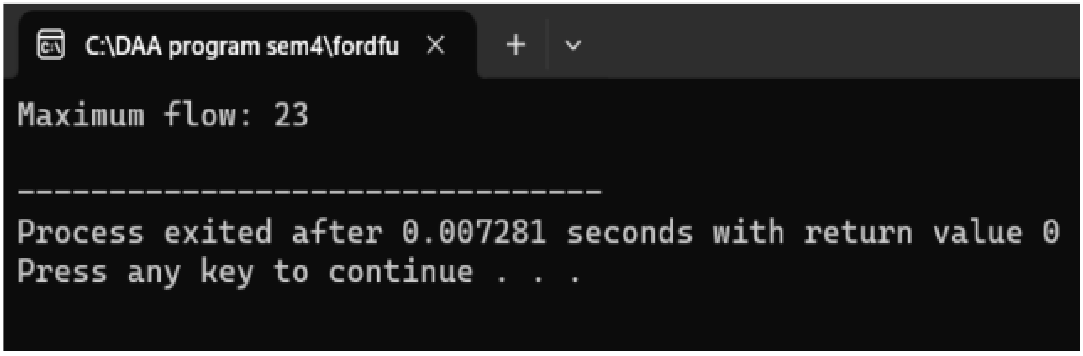
Q5)Write a program to implement Ford-Fulkerson algorithm for Maximum Flow Problem?



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

const int MAXN = 10;

bool bfs(int graph[MAXN][MAXN], int n, int source, int sink, int parent[]) {
    bool visited[MAXN];
    memset(visited, false, sizeof(visited));
    queue<int> q;
    q.push(source);
    visited[source] = true;
    parent[source] = -1;
    while (!q.empty()) {
        int current = q.front();
        q.pop();
        for (int i = 0; i < n; i++) {
            if (!visited[i] && graph[current][i] > 0) {
                q.push(i);
                visited[i] = true;
                parent[i] = current;
                if (i == sink) {
                    return true;
                }
            }
        }
    }
    return false;
}

int fordFulkerson(int graph[MAXN][MAXN], int n, int source, int sink) {
    int residual[MAXN][MAXN];
    memcpy(residual, graph, sizeof(residual));
    int parent[MAXN];
    int max_flow = 0;
    while (bfs(residual, n, source, sink, parent)) {
        int path_flow = -1;
        for (int v = sink; v != source; v = parent[v]) {
            int u = parent[v];
            path_flow = min(path_flow, residual[u][v]);
        }
        for (int v = sink; v != source; v = parent[v]) {
            int u = parent[v];
            residual[u][v] -= path_flow;
            residual[v][u] += path_flow;
        }
        max_flow += path_flow;
    }
```



```
    return max_flow;
}

int main() {
    int graph[MAXN][MAXN] = {
        {0, 16, 13, 0, 0, 0},
        {0, 0, 10, 12, 0, 0},
        {0, 4, 0, 0, 14, 0},
        {0, 0, 9, 0, 0, 20},
        {0, 0, 0, 7, 0, 4},
        {0, 0, 0, 0, 0, 0}
    };
    int n = 6;
    int source = 0;
    int sink = 5;
    int max_flow = fordFulkerson(graph, n, source, sink);
    cout << "Maximum flow: " << max_flow << endl;
    return 0;
}
```



```
Maximum flow: 23

--------------------------------
Process exited after 0.007281 seconds with return value 0
Press any key to continue . . .
```