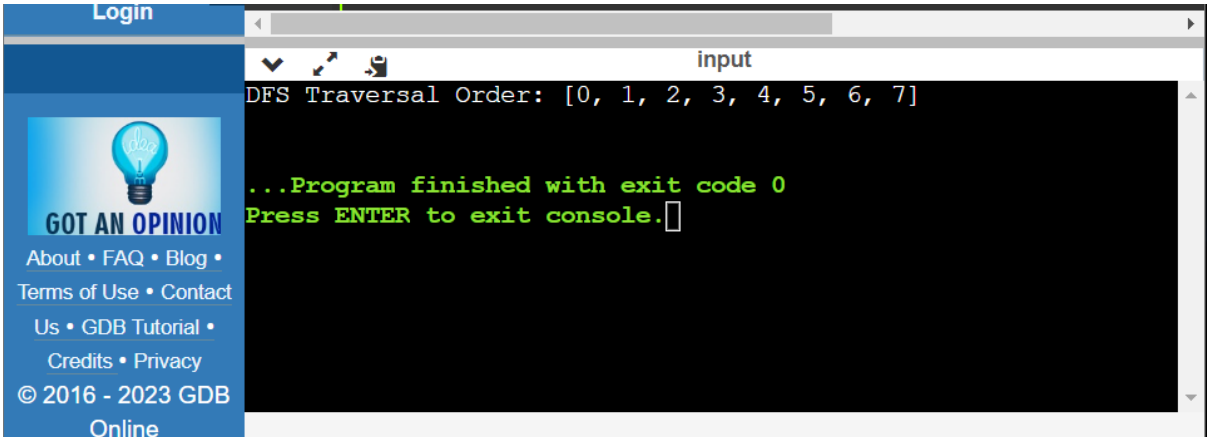
**Problem 1 : Given an undirected graph, return a vector of all nodes by traversing the graph using depth-first search (DFS).**

```
def dfs(graph, start_node, visited, traversal_order):
    visited[start_node] = True
    traversal_order.append(start_node)

    for neighbor in graph[start_node]:
        if not visited[neighbor]:
            dfs(graph, neighbor, visited, traversal_order)

def dfs_traversal(graph):
    num_nodes = len(graph)
    visited = [False] * num_nodes
    traversal_order = []

    for node in range(num_nodes):
        if not visited[node]:
            dfs(graph, node, visited, traversal_order)

    return traversal_order

example_graph = {
    0: [1, 2],
    1: [0, 2, 3],
    2: [0, 1, 3],
    3: [1, 2, 4],
    4: [3, 5],
    5: [4],
    6: [7],
    7: [6]
}
```

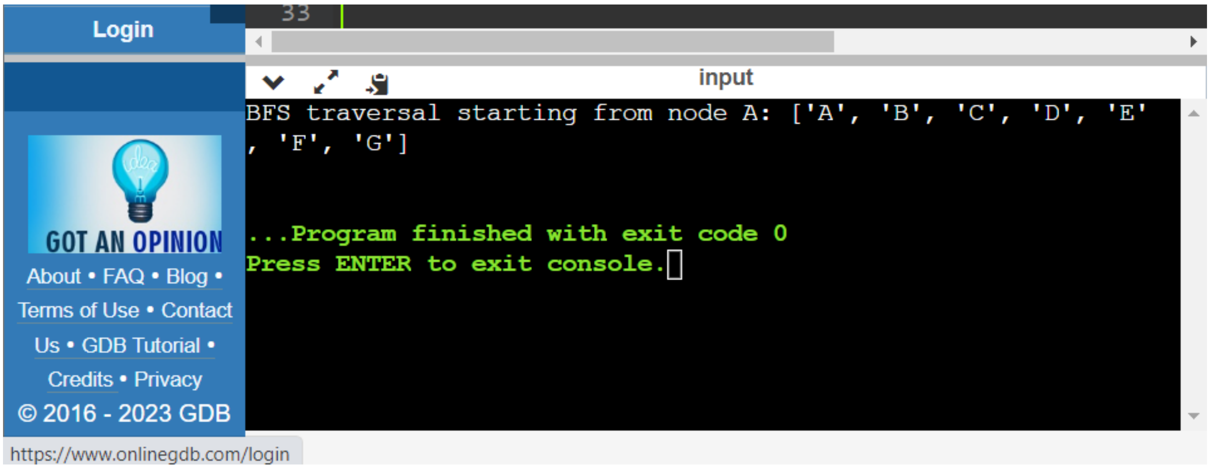
```
traversal_result = dfs_traversal(example_graph)

print("DFS Traversal Order:", traversal_result)
```



**Problem – 2 :** Given an undirected graph, return a vector of all nodes by traversing the graph using breadth-first search (BFS).

```
from collections import deque


def bfs(graph, start_node):
    visited = set()
    queue = deque([start_node])
    visited.add(start_node)
    result = []

    while queue:
        current_node = queue.popleft()
        result.append(current_node)

        for neighbor in graph[current_node]:
            if neighbor not in visited:
                visited.add(neighbor)
                queue.append(neighbor)

    return result


graph = {
    'A': ['B', 'C'],
    'B': ['A', 'D', 'E'],
    'C': ['A', 'F', 'G'],
    'D': ['B'],
    'E': ['B'],
    'F': ['C'],
    'G': ['C']
}
```

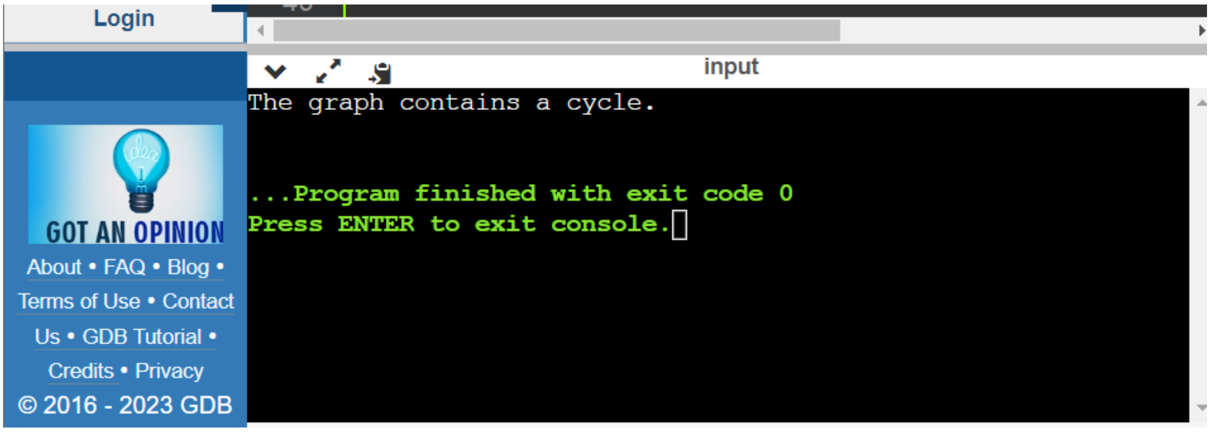
```
start_node = 'A'

bfs_result = bfs(graph, start_node)

print("BFS traversal starting from node {}: {}".format(start_node, bfs_result))
```



**Problem – 3** Given an undirected graph with V vertices and E edges, check whether it contains any cycle or not. (using DFS)

```
from collections import defaultdict


class Graph:
    def __init__(self, vertices):
        self.V = vertices
        self.graph = defaultdict(list)

    def add_edge(self, u, v):
        self.graph[u].append(v)
        self.graph[v].append(u)

    def is_cyclic_util(self, v, visited, parent):
        visited[v] = True

        for neighbor in self.graph[v]:
            if not visited[neighbor]:
                if self.is_cyclic_util(neighbor, visited, v):
                    return True
            elif parent != neighbor:
                return True

        return False

    def contains_cycle(self):
        visited = [False] * self.V

        for i in range(self.V):
            if not visited[i]:
                if self.is_cyclic_util(i, visited, -1):
```

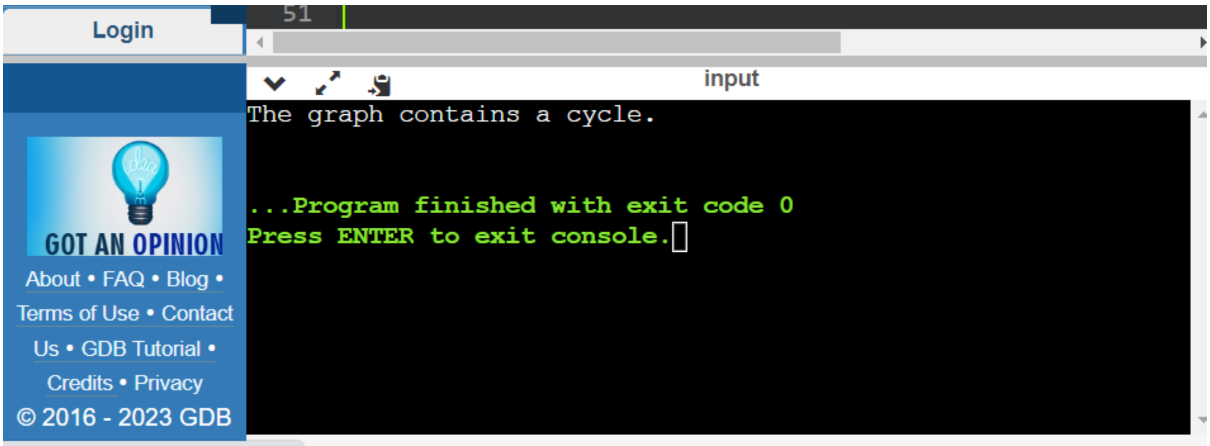
```
            return True

        return False



V = 5
E = 4
g = Graph(V)
edges = [(0, 1), (1, 2), (2, 1), (3, 4)]
for u, v in edges:
    g.add_edge(u, v)

if g.contains_cycle():
    print("The graph contains a cycle.")
else:
    print("The graph does not contain any cycle.")
```



**Problem – 4** Given an undirected graph with V vertices and E edges, check whether it contains any cycle or not. (using BFS)

```
from collections import defaultdict, deque


class Graph:
    def __init__(self, vertices):
        self.V = vertices
        self.graph = defaultdict(list)

    def add_edge(self, u, v):
        self.graph[u].append(v)
        self.graph[v].append(u)

    def is_cyclic_util(self, v, visited, parent):
        queue = deque([(v, parent)])
        visited[v] = True

        while queue:
            current_node, parent = queue.popleft()

            for neighbor in self.graph[current_node]:
                if not visited[neighbor]:
                    queue.append((neighbor, current_node))
                    visited[neighbor] = True
                elif parent != neighbor:
                    return True

        return False

    def contains_cycle(self):
        visited = [False] * self.V
```

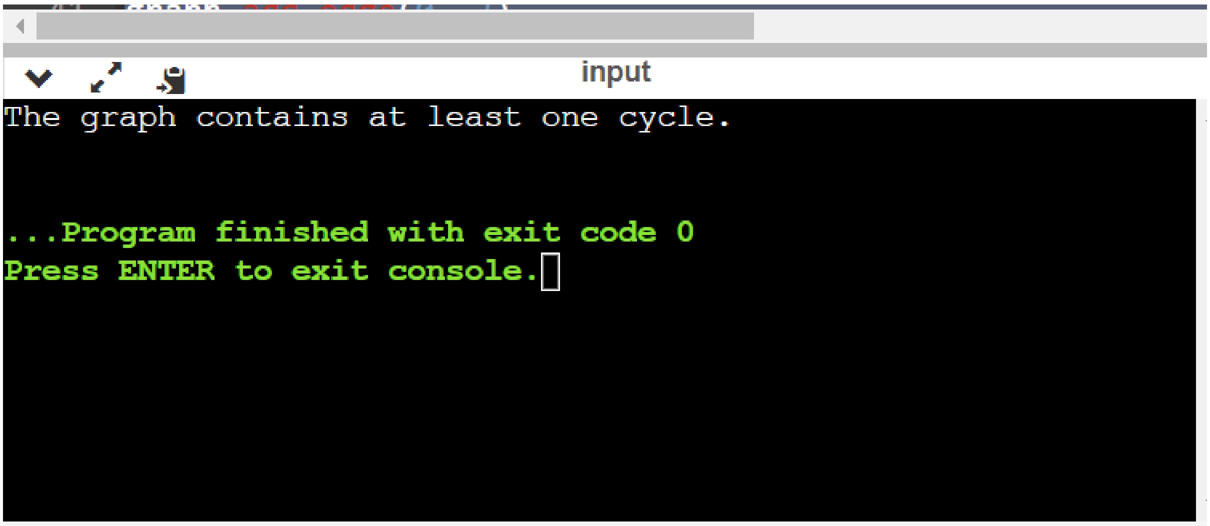
```
        for v in range(self.V):
            if not visited[v]:
                if self.is_cyclic_util(v, visited, -1):
                    return True

        return False

V = 4
E = 4
g = Graph(V)

edges = [(0, 1), (1, 2), (2, 3), (3, 0)]

for u, v in edges:
    g.add_edge(u, v)

if g.contains_cycle():
    print("The graph contains a cycle.")
else:
    print("The graph does not contain any cycle.")
```



**Problem 5 Given an directed graph with V vertices and E edges, check whether it contains any cycle or not. (using DFS)**

```
from collections import defaultdict


class Graph:
  def __init__(self, vertices):
    self.vertices = vertices
    self.graph = defaultdict(list)

  def add_edge(self, u, v):
    self.graph[u].append(v)

  def is_cyclic_util(self, v, visited, recursion_stack):
    visited[v] = True
    recursion_stack[v] = True

    for neighbor in self.graph[v]:
      if not visited[neighbor]:
        if self.is_cyclic_util(neighbor, visited, recursion_stack):
          return True
      elif recursion_stack[neighbor]:
        return True

    recursion_stack[v] = False
    return False

  def contains_cycle(self):
    visited = [False] * self.vertices
    recursion_stack = [False] * self.vertices

    for v in range(self.vertices):
```

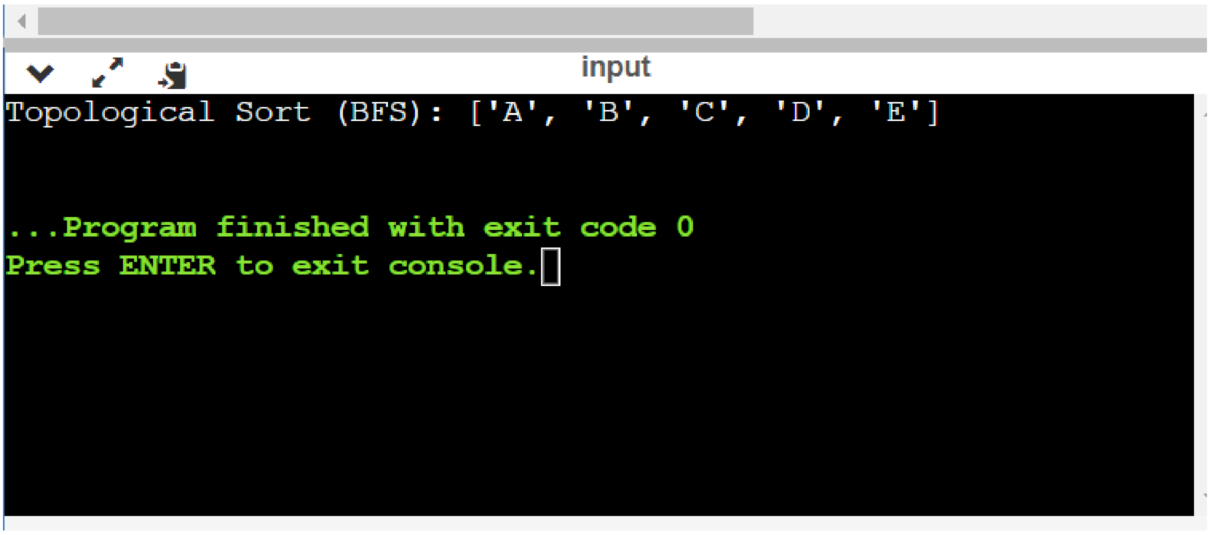
```
            if not visited[v]:
                if self.is_cyclic_util(v, visited, recursion_stack):
                    return True

        return False

V = 4
E = 6

graph = Graph(V)
graph.add_edge(0, 1)
graph.add_edge(0, 2)
graph.add_edge(1, 2)
graph.add_edge(2, 0)
graph.add_edge(2, 3)
graph.add_edge(3, 3)

if graph.contains_cycle():
    print("The graph contains at least one cycle.")
else:
    print("The graph does not contain any cycle.")
```



**Problem – 6 : Topological Sort (BFS)**

```
from collections import defaultdict, deque


def topological_sort_bfs(graph):
    in_degree = {node: 0 for node in graph}
    for node in graph:
        for neighbor in graph[node]:
            in_degree[neighbor] += 1

    queue = deque()
    for node in in_degree:
        if in_degree[node] == 0:
            queue.append(node)

    topological_order = []
    while queue:
        node = queue.popleft()
        topological_order.append(node)
        for neighbor in graph[node]:
            in_degree[neighbor] -= 1
            if in_degree[neighbor] == 0:
                queue.append(neighbor)

    if len(topological_order) != len(graph):
        # The graph contains cycles, so topological sort is not possible
        return None

    return topological_order


graph = {
    'A': ['B', 'C'],
```

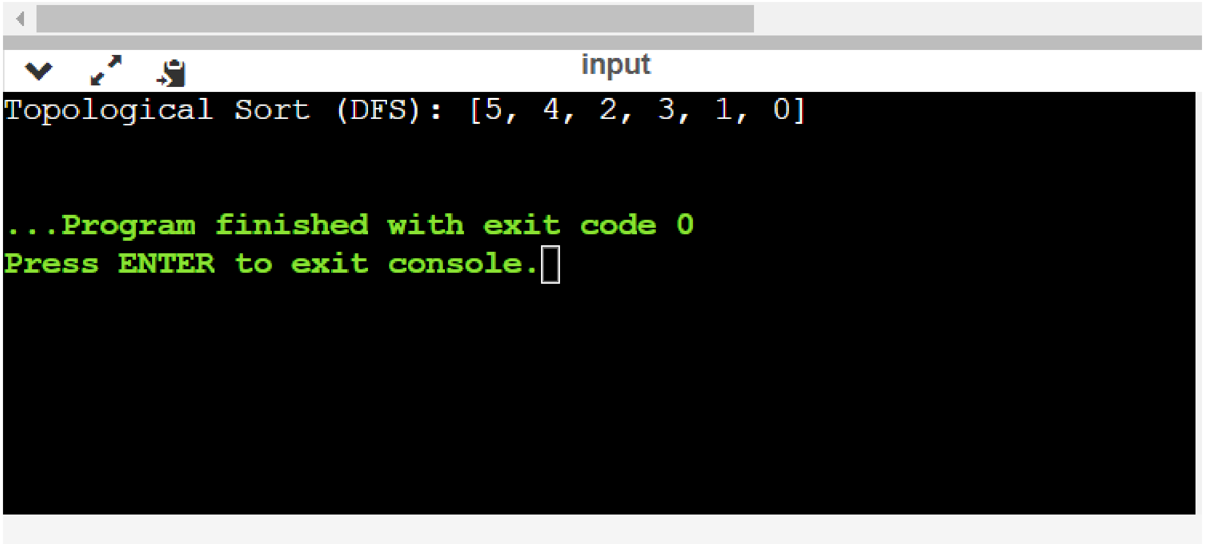
```
    'B': ['D'],
    'C': ['D'],
    'D': ['E'],
    'E': []
}

result = topological_sort_bfs(graph)
if result is not None:
    print("Topological Sort (BFS):", result)
else:
    print("The graph contains cycles. Topological Sort is not possible.")
```



**Problem – 7 : Topological Sort (DFS)**

```
from collections import defaultdict


class Graph:
    def __init__(self):
        self.graph = defaultdict(list)

    def add_edge(self, u, v):
        self.graph[u].append(v)

    def topological_sort_util(self, v, visited, stack):
        visited[v] = True

        for neighbor in self.graph[v]:
            if not visited[neighbor]:
                self.topological_sort_util(neighbor, visited, stack)

        stack.append(v)

    def topological_sort(self):
        visited = [False] * (max(self.graph) + 1)
        stack = []

        for i in range(len(visited)):
            if not visited[i]:
                self.topological_sort_util(i, visited, stack)

        return stack[::-1]

g = Graph()
g.add_edge(5, 2)
```

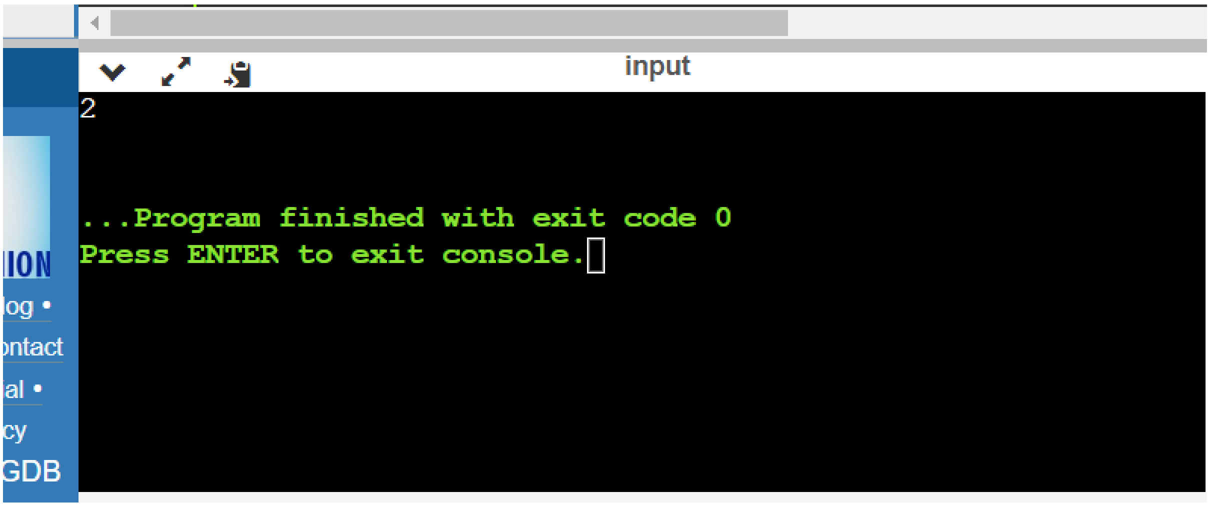
```
g.add_edge(5, 0)
g.add_edge(4, 0)
g.add_edge(4, 1)
g.add_edge(2, 3)
g.add_edge(3, 1)

print("Topological Sort (DFS):", g.topological_sort())
```



**Problem – 8** Given a boolean 2D matrix grid of size N x M. You have to find the number of distinct islands where a group of connected 1s (horizontally or vertically) forms an island. Two islands are considered to be distinct if and only if one island is equal to another (not rotated or reflected).

```
def numDistinctIslands(grid):
    def dfs(x, y, shape):
        if 0 <= x < len(grid) and 0 <= y < len(grid[0]) and grid[x][y] == 1:
            grid[x][y] = 0
            shape.append((x, y))
            dfs(x + 1, y, shape)
            dfs(x - 1, y, shape)
            dfs(x, y + 1, shape)
            dfs(x, y - 1, shape)

    unique_shapes = set()
    for i in range(len(grid)):
        for j in range(len(grid[0])):
            if grid[i][j] == 1:
                shape = []
                dfs(i, j, shape)
                unique_shapes.add(tuple(shape))

    return len(unique_shapes)


grid = [
    [1, 1, 0, 0, 0],
    [1, 1, 0, 0, 0],
    [0, 0, 0, 1, 1],
    [0, 0, 0, 1, 1]
]
```

```
print(numDistinctIslands(grid))
```



**Problem – 9,10 :** Bipartite Check using :

9. DFS

10. BFS

```
from collections import deque


def is_bipartite_bfs(graph, start_node):
    queue = deque([start_node])
    color = {start_node: 1}  # Colors: 1 and -1 represent the two partitions.


    while queue:
        current_node = queue.popleft()
        for neighbor in graph[current_node]:
            if neighbor not in color:
                color[neighbor] = -color[current_node]
                queue.append(neighbor)
            elif color[neighbor] == color[current_node]:
                return False


    return True


def is_bipartite_dfs(graph, start_node):
    stack = [(start_node, 1)]
    color = {}


    while stack:
        current_node, current_color = stack.pop()
        if current_node in color:
            if color[current_node] != current_color:
                return False
            continue
        color[current_node] = current_color
```

```
        next_color = -current_color
        stack.extend((neighbor, next_color) for neighbor in graph[current_node])

    return True

def is_bipartite(graph):
    start_node = next(iter(graph))
    return is_bipartite_bfs(graph, start_node) and is_bipartite_dfs(graph, start_node)



graph = {
    1: [2, 3],
    2: [1, 4],
    3: [1, 4],
    4: [2, 3]
}

print(is_bipartite(graph))
```