DAY-06

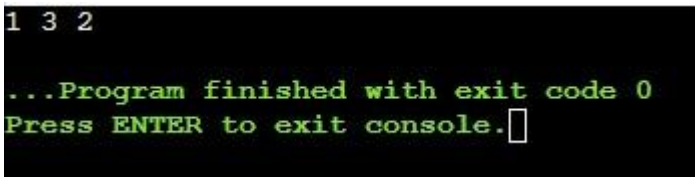
Name: Ayush Kumar
UID: 22BCS15297

Question 1

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

struct TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode() : val(0), left(nullptr), right(nullptr) {}
    TreeNode(int x) : val(x), left(nullptr), right(nullptr) {}      TreeNode(int x,
TreeNode* left, TreeNode* right) : val(x), left(left), right(right) {}
};


void inorderTraversalHelper(TreeNode* root, vector<int>& result) {
    if (root == nullptr) {
        return;
    }
    inorderTraversalHelper(root->left, result);  result.push_back(root->val);
    inorderTraversalHelper(root->right, result);
}


vector<int> inorderTraversal(TreeNode* root) {
    vector<int> result;      inorderTraversalHelper(root, result);
    return result;
}
int main() {
     TreeNode* root = new TreeNode(1);      root->right = new
TreeNode(2);
    root->right->left = new TreeNode(3);

    vector<int> result = inorderTraversal(root);
 for (int val : result) {
        cout << val << " ";
    }
delete root->right->left;      delete root-
>right;
```

```
    delete root;

    return 0;
}
```

Output:

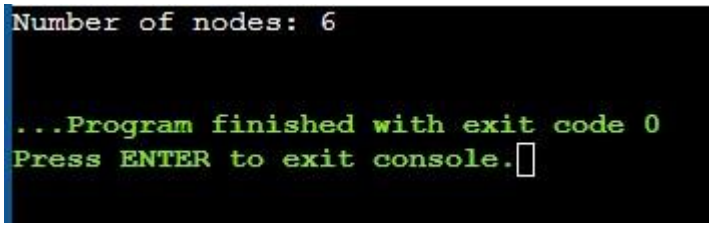


Question 2

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

struct TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode() : val(0), left(nullptr), right(nullptr) {}
    TreeNode(int x) : val(x), left(nullptr), right(nullptr) {}      TreeNode(int x,
TreeNode* left, TreeNode* right) : val(x), left(left), right(right) {}
};

int computeDepth(TreeNode* node) {
    int depth = 0;     while
(node) {         depth++;
node = node->left;
    }
    return depth;
}

int countNodes(TreeNode* root) {
    if (!root) return 0;

    int leftDepth = computeDepth(root->left);
    int rightDepth = computeDepth(root->right);
```

```
    if (leftDepth == rightDepth) {

        return (1 << leftDepth) + countNodes(root->right);
    } else {        return (1 << rightDepth) + countNodes(root->left);
    }
}

int main() {    // Example
usage:
    TreeNode* root = new TreeNode(1);    root->left = new
TreeNode(2);    root->right = new TreeNode(3);    root-
>left->left = new TreeNode(4);    root->left->right = new
TreeNode(5);    root->right->left = new TreeNode(6);

    cout << "Number of nodes: " << countNodes(root) << endl;    delete root->left-
>left;    delete root->left->right;    delete root->right->left;    delete root->left;
delete root->right;
    delete root;

    return 0;
}
```

Output:

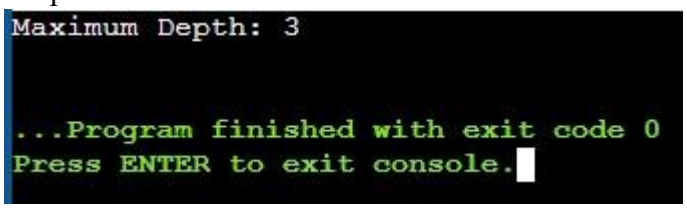


Question 3

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

struct TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
```

```
    TreeNode() : val(0), left(nullptr), right(nullptr) {}
    TreeNode(int x) : val(x), left(nullptr), right(nullptr) {}      TreeNode(int x,
TreeNode* left, TreeNode* right) : val(x), left(left), right(right) {}
};

int maxDepth(TreeNode* root) {
    if (!root) return 0;
    int leftDepth = maxDepth(root->left);       int rightDepth
= maxDepth(root->right);
    return max(leftDepth, rightDepth) + 1;
}

int main() {

    TreeNode* root = new TreeNode(1);     root->left = new
TreeNode(2);     root->right = new TreeNode(3);     root-
>left->left = new TreeNode(4);     root->left->right = new
TreeNode(5);
    root->right->right = new TreeNode(6);

    cout << "Maximum Depth: " << maxDepth(root) << endl;

    delete root->left->left;
     delete root->left->right;
    delete root->right->right;     delete
root->left;     delete root->right;
    delete root;

    return 0;
}
```

Output:



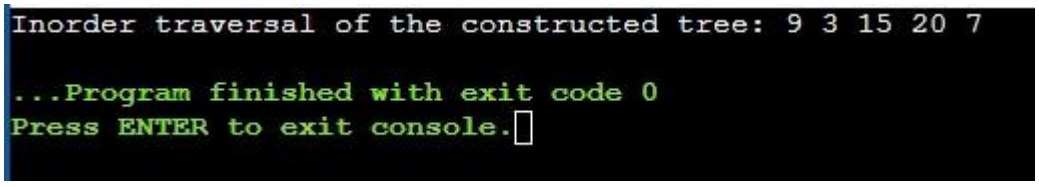
Question 4

```
#include <iostream>
#include <vector> #include
<unordered_map>
```

```
using namespace std;

struct TreeNode {     int val;
   TreeNode* left;
   TreeNode* right;
   TreeNode() : val(0), left(nullptr), right(nullptr) {}
   TreeNode(int x) : val(x), left(nullptr), right(nullptr) {}      TreeNode(int x,
TreeNode* left, TreeNode* right) : val(x), left(left), right(right) {}
};

TreeNode* buildTreeHelper(vector<int>& preorder, int preStart, int preEnd,
                          vector<int>& inorder, int inStart, int inEnd,
unordered_map<int, int>& inorderIndexMap) {     if (preStart > preEnd || inStart >
inEnd) {
       return nullptr;
   }

   int rootVal = preorder[preStart];     TreeNode* root = new
TreeNode(rootVal);

   int rootIndex = inorderIndexMap[rootVal];

   int leftSubtreeSize = rootIndex - inStart;

   root->left = buildTreeHelper(preorder, preStart + 1, preStart
+ leftSubtreeSize,
                                inorder, inStart, rootIndex - 1,
inorderIndexMap);
   root->right = buildTreeHelper(preorder, preStart + leftSubtreeSize + 1, preEnd,
                                 inorder, rootIndex + 1, inEnd,
inorderIndexMap);

   return root;
}


TreeNode* buildTree(vector<int>& preorder, vector<int>& inorder) {

   unordered_map<int, int> inorderIndexMap;     for (int i = 0; i <
inorder.size(); i++) {
       inorderIndexMap[inorder[i]] = i;
   }

   return buildTreeHelper(preorder, 0, preorder.size() - 1,                          inorder, 0,
inorder.size() - 1,                          inorderIndexMap);
}
```

```
void printInorder(TreeNode* root) {     if (!root)
return;     printInorder(root->left);     cout <<
root->val << " ";
   printInorder(root->right);
}

int main() {

   vector<int> preorder = {3, 9, 20, 15, 7};
   vector<int> inorder = {9, 3, 15, 20, 7};

   TreeNode* root = buildTree(preorder, inorder);

   cout << "Inorder traversal of the constructed tree: ";     printInorder(root);

   return 0;
}
```

Output:

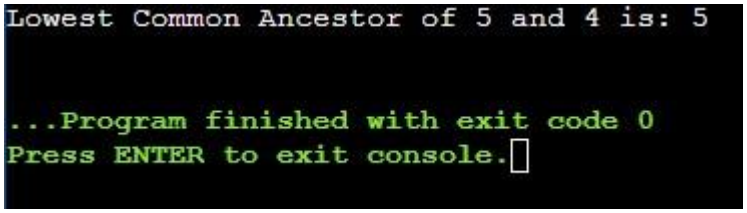


Question 5

```
#include <iostream> using
namespace std;
struct TreeNode {
   int val;
   TreeNode* left;
   TreeNode* right;
   TreeNode(int x) : val(x), left(nullptr), right(nullptr) {}
};
```

```
TreeNode* lowestCommonAncestor(TreeNode* root,
TreeNode* p, TreeNode* q) {
    if (!root) return nullptr;
    if (root == p || root == q) return root;
    TreeNode* left = lowestCommonAncestor(root->left, p, q);
    TreeNode* right = lowestCommonAncestor(root->right, p, q);

    if (left && right) {
        return root;
    }

    return left ? left : right;
}
int main() {
    TreeNode* root = new TreeNode(3);     root->left = new
TreeNode(5);     root->right = new TreeNode(1);     root-
>left->left = new TreeNode(6);     root->left->right = new
TreeNode(2);     root->right->left = new TreeNode(0);
root->right->right = new TreeNode(8);     root->left->right-
>left = new TreeNode(7);
    root->left->right->right = new TreeNode(4);

    TreeNode* p = root->left;
    TreeNode* q = root->left->right->right;

    TreeNode* lca = lowestCommonAncestor(root, p, q);     if (lca) {
        cout << "Lowest Common Ancestor of " << p->val << " and
" << q->val << " is: " << lca->val << endl;
    } else {
        cout << "No common ancestor found." << endl;
    }

    return 0;
}
```

Output:

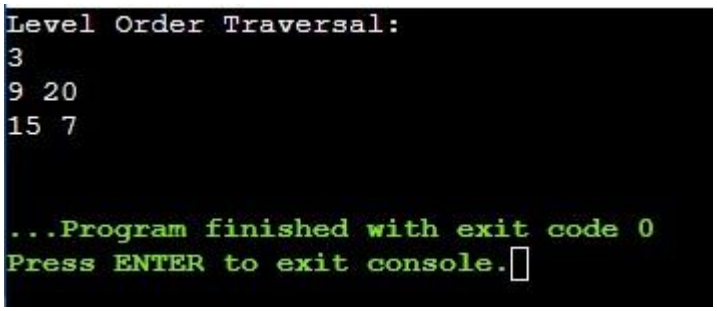


Question 6

```
#include <iostream>
#include <vector> #include
<queue> using namespace std;
struct TreeNode {
   int val;
   TreeNode* left;
   TreeNode* right;
   TreeNode(int x) : val(x), left(nullptr), right(nullptr) {}
};
vector<vector<int>> levelOrder(TreeNode* root) {     vector<vector<int>> result;
   if (!root) return result;
queue<TreeNode*> q;
q.push(root);     while (!q.empty())
{         int levelSize = q.size();
       vector<int> currentLevel;

       for (int i = 0; i < levelSize; i++) {             TreeNode*
node = q.front();             q.pop();
          currentLevel.push_back(node->val);             if
(node->left) q.push(node->left);
          if (node->right) q.push(node->right);
       }

       result.push_back(currentLevel);
   }

   return result;
}

int main() {
   TreeNode* root = new TreeNode(3);     root->left = new
TreeNode(9);     root->right = new TreeNode(20);     root-
>right->left = new TreeNode(15);     root->right->right =
new TreeNode(7);

   vector<vector<int>> traversal = levelOrder(root);

   cout << "Level Order Traversal:" << endl;     for (const
auto& level : traversal) {
       for (int val : level) {             cout
<< val << " ";         }
       cout << endl;
   }
```

```
    return 0;
}
```

Output:

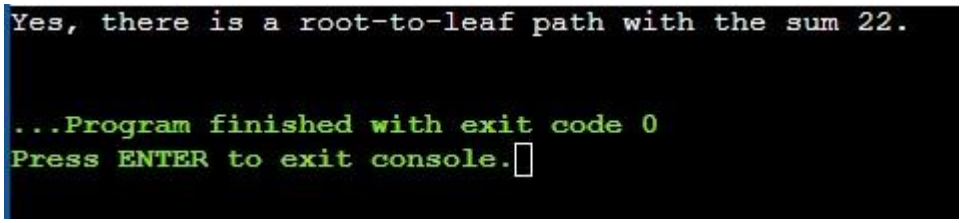


Question 7

```
#include <iostream> using
namespace std;
struct TreeNode {     int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode(int x) : val(x), left(nullptr), right(nullptr) {}
};
bool hasPathSum(TreeNode* root, int targetSum) {     if (!root)
return false;      if (!root->left && !root->right) {
        return root->val == targetSum;
    }
    int remainingSum = targetSum - root->val;     return
hasPathSum(root->left, remainingSum) || hasPathSum(root->right,
remainingSum);
}

int main() {
    TreeNode* root = new TreeNode(5);     root->left = new
TreeNode(4);     root->right = new TreeNode(8);     root-
>left->left = new TreeNode(11);     root->right->left = new
TreeNode(13);     root->right->right = new TreeNode(4);
root->left->left->left = new TreeNode(7);     root->left-
>left->right = new TreeNode(2);
    root->right->right->right = new TreeNode(1);

    int targetSum = 22;
    if (hasPathSum(root, targetSum)) {
```

```
        cout << "Yes, there is a root-to-leaf path with the sum " << targetSum << "." <<
endl;
    } else {
        cout << "No, there is no root-to-leaf path with the sum " << targetSum << "." <<
endl;
    }
    return 0;
}
```

Output:



Question 8

```
#include <iostream>
#include <vector>
#include <unordered_map> #include
<algorithm>
using namespace std;

class UnionFind { public:
vector<int> parent, rank;

    UnionFind(int n) : parent(n), rank(n, 0) {          for (int i =
0; i < n; ++i) {
            parent[i] = i;
        }
    }

    int find(int x) {          if (x !=
parent[x]) {
            parent[x] = find(parent[x]);
```

```
        }
        return parent[x];
    }

    void unite(int x, int y) {         int rootX = find(x);
int rootY = find(y);         if (rootX != rootY) {             if
(rank[rootX] > rank[rootY]) {                 parent[rootY] =
rootX;             } else if (rank[rootX] < rank[rootY]) {
parent[rootX] = rootY;
            } else {
                parent[rootY] = rootX;                 rank[rootX]++;
            }
        }
    }
};

int numberOfGoodPaths(vector<int>& vals, vector<vector<int>>& edges) {
    int n = vals.size();     vector<vector<int>>
adj(n);     for (const auto& edge : edges) {
adj[edge[0]].push_back(edge[1]);
adj[edge[1]].push_back(edge[0]);
    }
    vector<int> sortedNodes(n);
    iota(sortedNodes.begin(), sortedNodes.end(), 0);
    sort(sortedNodes.begin(), sortedNodes.end(), [&](int a, int b)
{
        return vals[a] < vals[b];
    });

    UnionFind uf(n);
    unordered_map<int, int> count;
    int goodPaths = 0;

    for (int node : sortedNodes) {         int
nodeValue = vals[node];

        count[nodeValue]++;
        goodPaths++;

        for (int neighbor : adj[node]) {             if
(vals[neighbor] <= nodeValue) {
uf.unite(node, neighbor);
            }
        }
        unordered_map<int, int> componentCount;
```

```
        for (int neighbor : adj[node]) {            if
(vals[neighbor] <= nodeValue) {                int root =
uf.find(neighbor);
                componentCount[root]++;
            }
        }

        for (auto& [_, size] : componentCount) {
            goodPaths += size * (size - 1) / 2;
        }
    }

    return goodPaths;
}

int main() {
    vector<int> vals = {1, 3, 2, 1, 3};
    vector<vector<int>> edges = {{0, 1}, {0, 2}, {2, 3}, {2, 4}};

    cout << "Number of good paths: " <<
numberOfGoodPaths(vals, edges) << endl;

    return 0;
}
```

Output:

Input:

```plaintext
vals = [1, 3, 2, 1, 3]
edges = [[0, 1], [0, 2], [2, 3], [2, 4]]
```

Output:

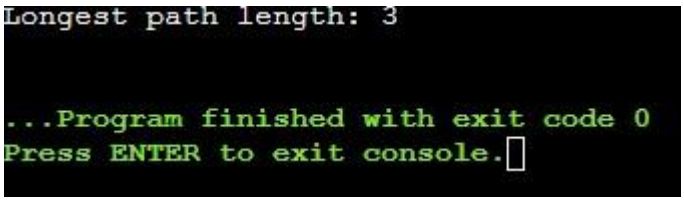
```plaintext
Number of good paths: 6
```

Question 9

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

int dfs(int node, const vector<vector<int>>& adj, const string& s, int&
maxPathLength) {
   int longest = 0, secondLongest = 0;

   for (int neighbor : adj[node]) {
      int childPath = dfs(neighbor, adj, s, maxPathLength);
      if (s[node] != s[neighbor]) {            if
(childPath > longest) {
secondLongest = longest;                longest =
childPath;
         } else if (childPath > secondLongest) {
            secondLongest = childPath;
         }
      }
   }
   maxPathLength = max(maxPathLength, longest + secondLongest + 1);

   return longest + 1;
}

int longestPath(vector<int>& parent, string s) {
   int n = parent.size();
```

```
    vector<vector<int>> adj(n);     for (int i =
1; i < n; ++i) {
        adj[parent[i]].push_back(i);
    }

    int maxPathLength = 0;
    dfs(0, adj, s, maxPathLength);

    return maxPathLength;
}

int main() {
    vector<int> parent = {-1, 0, 0, 1, 1, 2};     string s =
"abacbe";

    cout << "Longest path length: " << longestPath(parent, s) << endl;
    return 0;
}
```

Output:



Question 10

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

class Solution { public:
    int maxComponents = 0;     int dfs(int node, const vector<vector<int>>&
adj, const vector<int>& values, vector<bool>& visited, int k) {
        visited[node] = true;         int subtreeSum =
values[node];          for (int neighbor :
adj[node]) {             if (!visited[neighbor]) {
                subtreeSum += dfs(neighbor, adj, values, visited, k);
            }
        }
        if (subtreeSum % k == 0) {
            maxComponents++;
            return 0;
        }
```

```
        return subtreeSum;
    }

    int componentValue(int n, vector<vector<int>>& edges,
vector<int>& values, int k) {
vector<vector<int>> adj(n);         for (const auto&
edge : edges) {
adj[edge[0]].push_back(edge[1]);
adj[edge[1]].push_back(edge[0]);
        }
        vector<bool> visited(n, false);         int totalSum = dfs(0,
adj, values, visited, k);         if (totalSum % k == 0) {
            maxComponents++;
        }

        return maxComponents;
    }
};

int main() {     Solution
sol;     int n = 5;
    vector<vector<int>> edges = {{0, 1}, {1, 2}, {1, 3}, {3, 4}};     vector<int> values
= {1, 2, 3, 4, 5};
    int k = 3;

    int result = sol.componentValue(n, edges, values, k);       cout << "Maximum
number of components: " << result << endl;

    return 0;
}
```

Output: