Tree

1) What is Tree?
Ans:
A tree is a hierarchical data structure.
Each node can have zero or more child nodes
There is a unique path from the root to every other node in the tree.

2)Key characteristics of a tree include.
Ans:
Root: The topmost node in the tree from which all other nodes are derived. It serves as the starting point for traversing the tree.

Edge: An edge represents the link or connection between two nodes.

Nodes: Each element in the tree is called a node. Nodes can be connected to other nodes through edges.

Parent and Child Nodes: A node that is connected to another node is referred to as the parent node, and the connected node is called its child node.

Leaf Nodes/External Node: A node which don't have any child

Branch/Internal Nodes: Internal nodes are nodes that have at least one child node. They are not leaf nodes.

Path: A path in a tree refers to a sequence of nodes connected by edges, starting from a specific node and leading to a destination node.

Depth: The depth of a binary tree is the number of edges on the longest path from the root node to a leaf node.
Height: The height of a tree is the maximum depth of any node in the tree.

Depth: Root to x (destination node) Node
Height: From x (destination) to root node

Subtree: A subtree is a smaller tree within a larger tree.

Sibling Nodes: Sibling nodes are nodes that have the same parent
Cousing Nodes: Cousin nodes in a tree refer to nodes that are at the same level or depth but do not share the same parent.

Ancestor : In a tree data structure, an ancestor of a node is any node that lies on the path from the root to that specific node.

Descendant : In a tree data structure, a descendant of a node is any node that is reachable by following a path from that specific node.

Diameter: The diameter of a tree is the longest path between any two nodes in the tree. (Number of node including two nodes)

Degree: The degree of a node in a tree refers to the number of edges connected to that node. It represents the count of immediate connections a node has with other nodes in the tree.

3) What is Binary Tree?

Ans:

A binary tree is a hierarchical data structure in which each node has at most two children, referred to as the left child and the right child.

4) Variant of Binary Tree.

Ans:

1) Perfect Binary Tree - All level are filled.

2) Complete Binary Tree - A complete binary tree is a binary tree in which every level is completely filled, except for the last level, which may be filled from left to right.

3) Full Binary Tree - Every Node has exactly 0 or 2 child

5) Hack Binary Tree:

1) Number of Nodes:

For a Perfect binary tree: Number of nodes = 2^(height + 1) - 1

For a complete binary tree: Number of nodes = 2^height - 1 + (number of leaf nodes)

2) Number of Edge:

For a Perfect binary tree: Number of nodes = 2^(height + 1) - 1 - 1

For a complete binary tree: Number of nodes = 2^height - 1 + (number of leaf nodes) -1

For a complete binary tree: 2^h - 1 + (number of leaf nodes) -1

3) Number of Leaf Nodes (or External Nodes) in a perfect Binary Tree:

Number of leaf nodes = (2^(height) - 1) / 2 = (number of nodes + 1) / 2

4) Maximum Number of Nodes on a perfect Binary Tree:

For a binary tree of height h: Maximum number of nodes = 2^(height + 1) - 1

5) Height of a Binary Tree:

For a binary tree: Height = maximum depth of any node in the tree

If the tree is empty: Height = -1

If the tree has only one node (root): Height = 0

6) Maximum possible Height of a Binary Tree with n Nodes:

For a binary tree with n nodes: Maximum height = n - 1

7) Number of Internal Nodes in a Binary Tree:
For a binary tree: Number of internal nodes = Total number of nodes - Number of leaf nodes

8) Maximum Width of a Binary Tree (Number of Nodes in the Widest Level):
For a binary tree: Maximum width = Maximum number of nodes in any level of the tree