

Tutorials



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## Definitions of Tree :

Tree is a non-linear data structure which organizes data in hierarchical structure and this is a recursive definition.

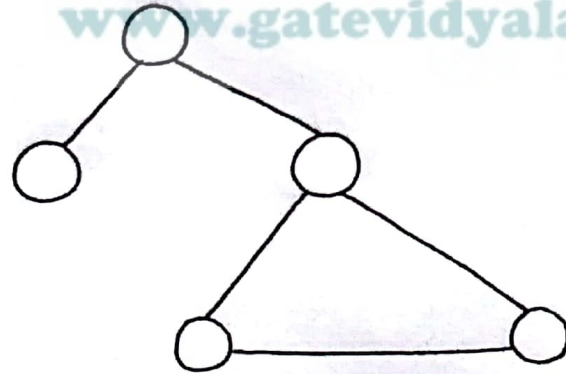
OR

A tree is a connected graph without any circuits.

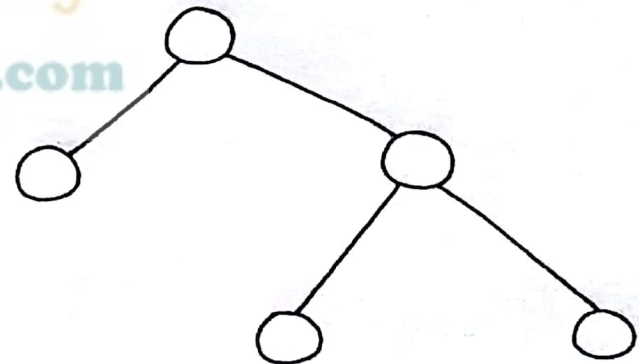
OR

If in a graph, there is one and only one path between every pair of vertices, then graph is a tree.

Example:



Graph which is not a tree

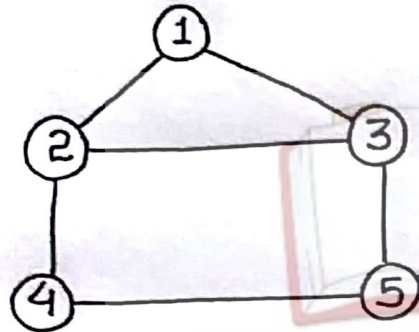


Graph which is a tree

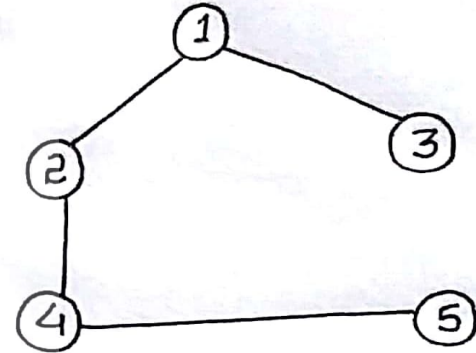
## Question:

Which of the following graphs are trees ?

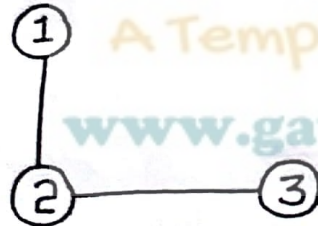
(A)



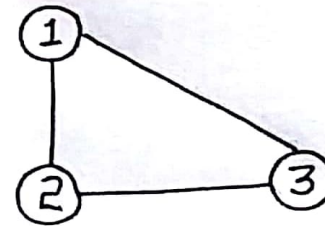
(B)



(C)



(D)



## Solution:

Only (B) and (C) are trees

# Properties of Trees:

- There is one and only one path between every pair of vertices in a tree.
- A tree with  $n$  vertices has  $n-1$  edges.
- A graph is a tree if and only if it is minimally connected.
- Any connected graph with  $n$  vertices and  $n-1$  edges is a tree.

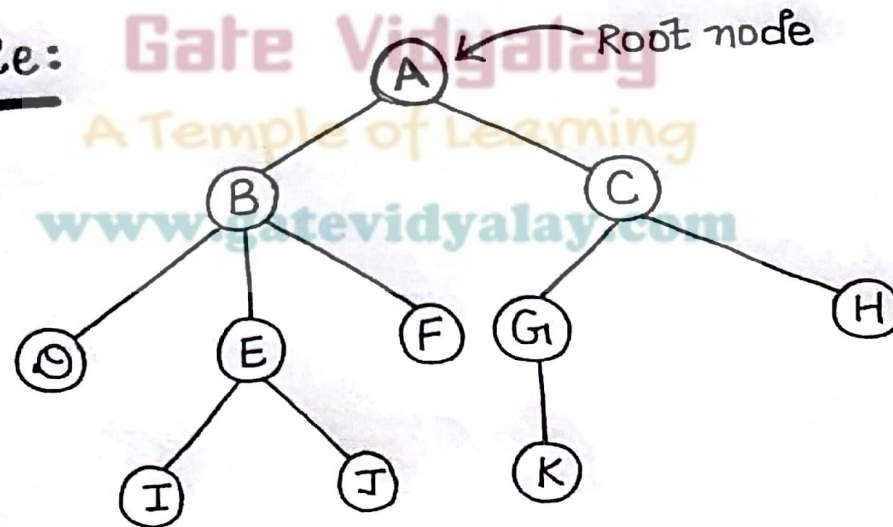
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# Basic Terminology

## 1) Root:

- Root node is the origin of tree data structure. It is the first node.
- In any tree, there must be only one root node and we can never have multiple root nodes in a tree.

## Example:

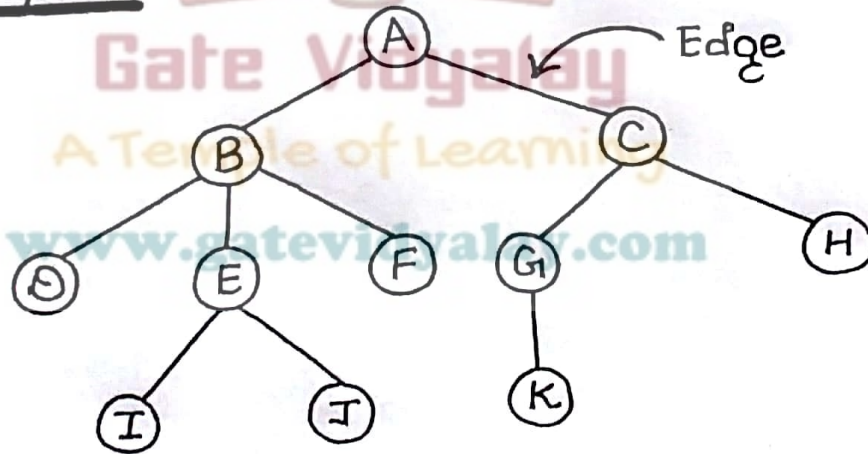


## 2) Edge:

- The connecting link between any two nodes is called as edge.

Remember: In a tree with 'n' number of nodes, there will be exactly 'n-1' number of edges

- Example:

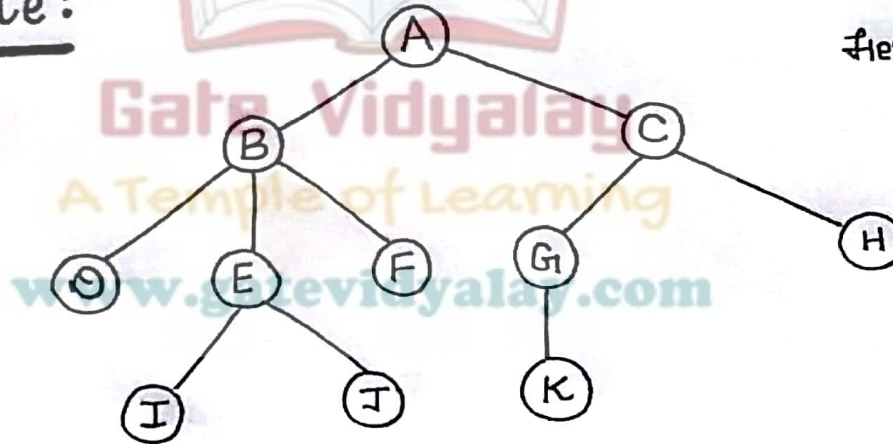


### 3. Parent:

- The node which has a branch from it to any other node is called as parent node.

In other words, the node which has child/children is called as parent node.

- Example:

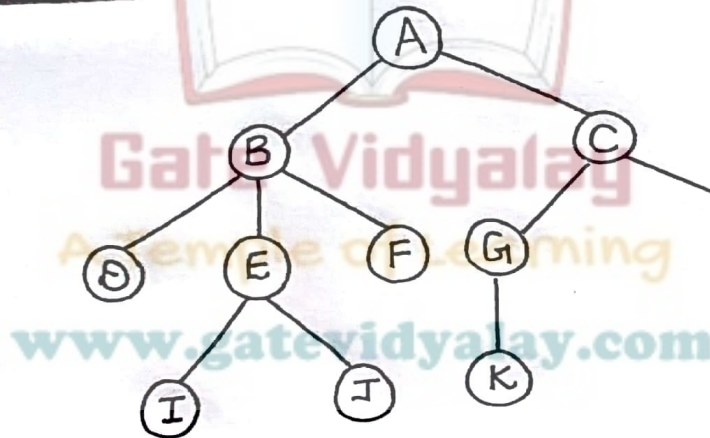


Here, A, B, C, E and G are parent nodes

## 4. Child :

- The node which is descendant of any node is called as child node. So, all the nodes except root node are child nodes.

### Example:



- Here, B and C are children of A
- G and H are children of C
- K is the only child of G etc

Note: In a tree, any parent node can have any number of child nodes.

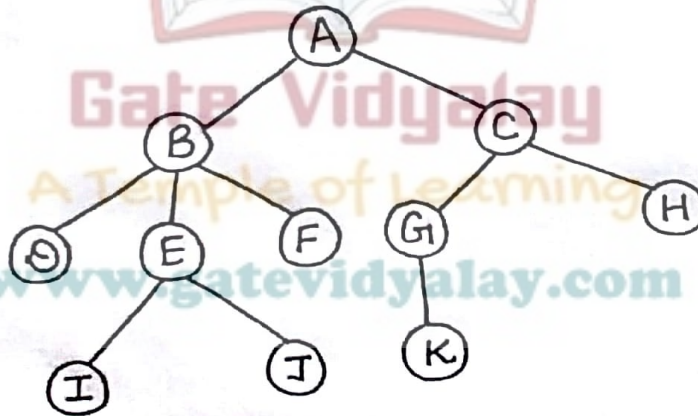


## 5. Siblings :

- Nodes which belong to the same parent are called as siblings.

In other words, nodes with the same parent are called as sibling nodes.

- Example:



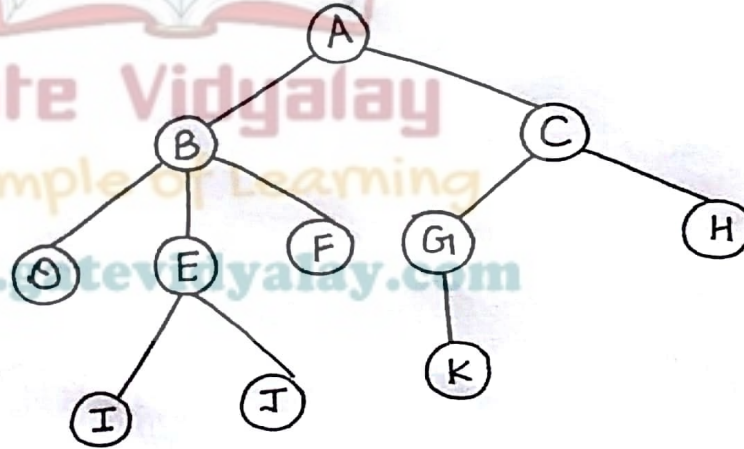
Here,

- B and C are siblings
- D, E and F are siblings
- G and H are siblings
- I and J are siblings

## 6. Degree:

- The total number of children of a node is called as degree of that node.
- Degree of a tree is the highest degree of a node among all the nodes in the tree.

### Example:



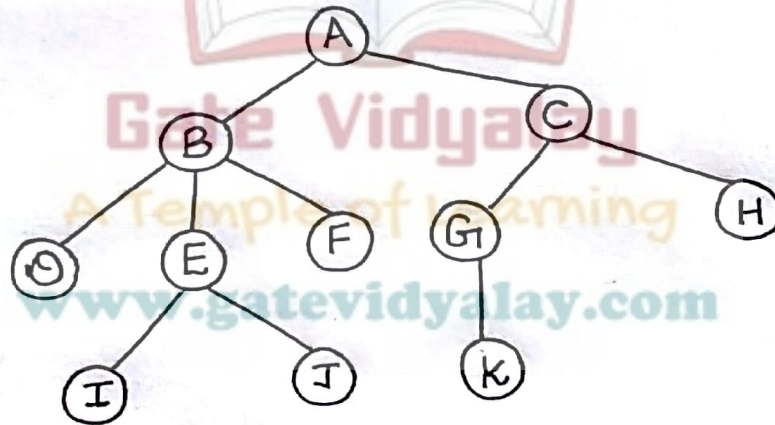
Here,

- Degree of B = 3
  - Degree of A = 2
  - Degree of F = 0
- etc

## 7. Internal Nodes:

- The node which has atleast one child is called as internal node. They are also called as non-terminal nodes.

### Example:



Here,

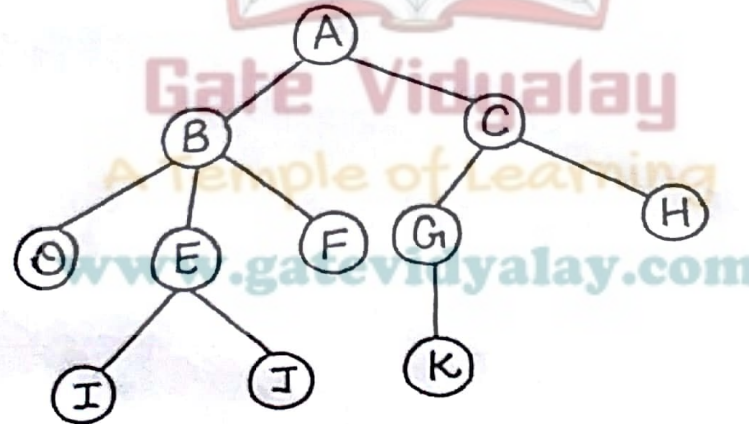
A, B, C, E and G are internal nodes

Note: Every non-leaf node is an internal node.

## 8. Leaf Nodes :

- The node which does not have a child is called as leaf node.
- The leaf nodes are also called as external nodes or terminal nodes.

• Example:



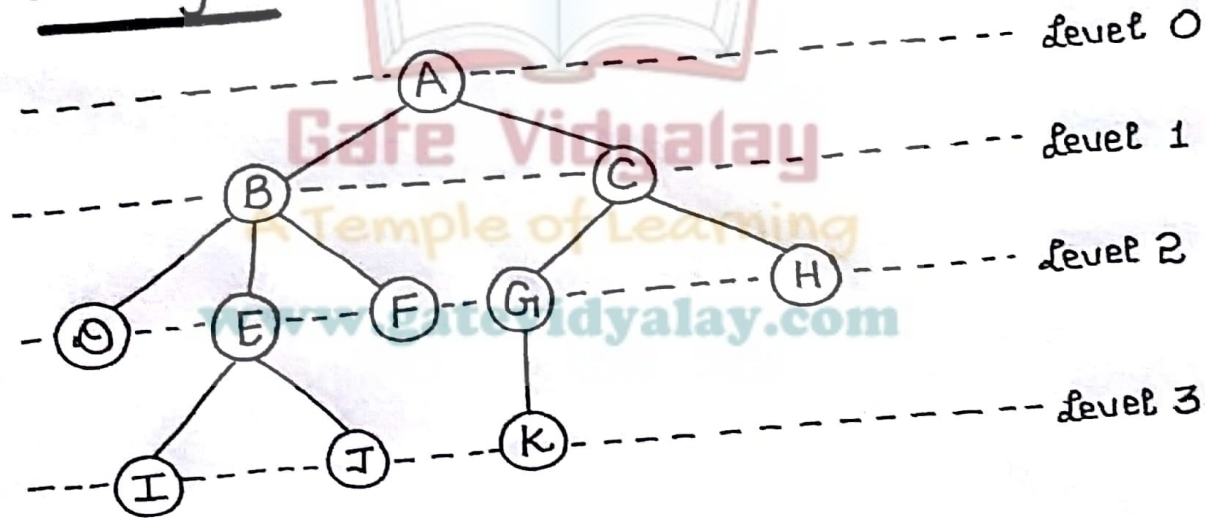
Here,

D, I, J, F, K and H  
are leaf nodes

## 9. Level:

- In a tree, each step from top to bottom is called as level and the level count starts with '0' and incremented by one at each level or step.

### • Example:



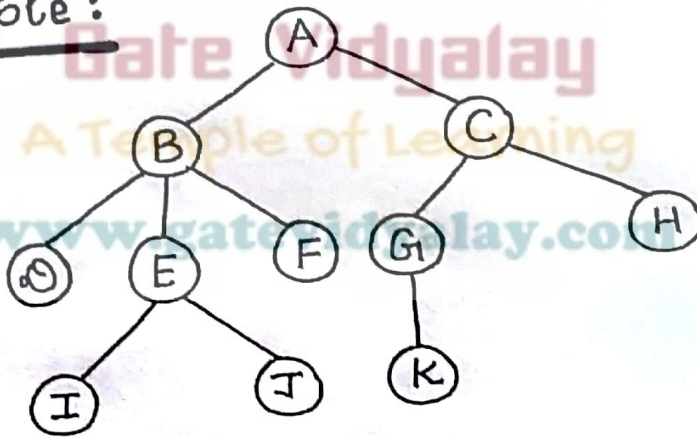
## 10. Height:

- The total number of edges from leaf node to a particular node in the longest path is called as height of that node.

Note:

- Height of the tree = height of the root node
- Height of all leaf nodes = 0

### Example:



Here,

- Height of K = 0
  - Height of B = 2
  - Height of A = 3
  - Height of G = 1
  - Height of H = 0
- etc

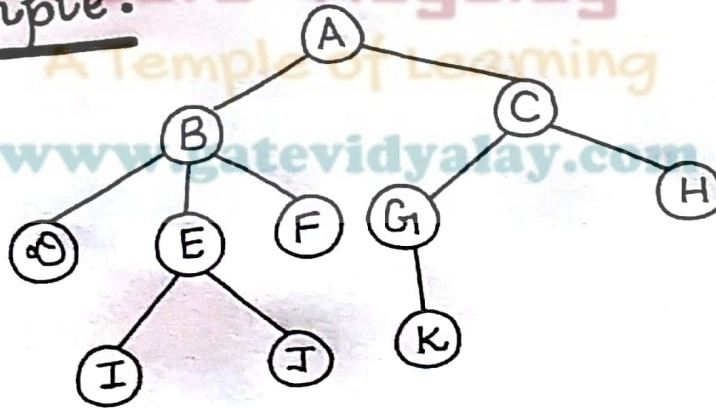
## 11. Depth:

- The total number of edges from root node to a particular node is called as depth of that node.

Note:

- Depth of the tree = Total number of edges from root node to a leaf node in the longest path
- Depth of the root node = 0

### Example:

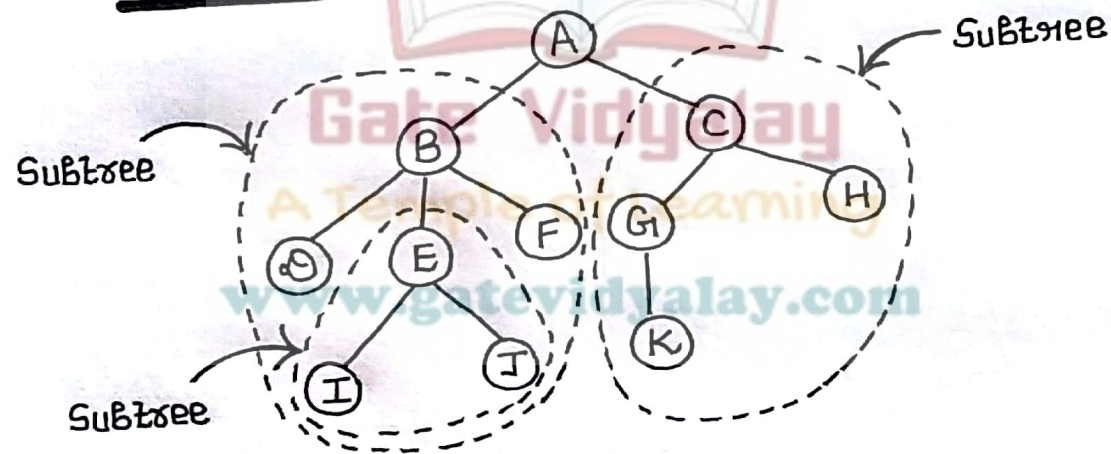


- Here,
- Depth of A = 0
  - Depth of B = 1
  - Depth of K = 3
- etc.

## 12. Subtree :

- In a tree, each child from a node forms a subtree recursively. Every child node will form a subtree on its parent node.

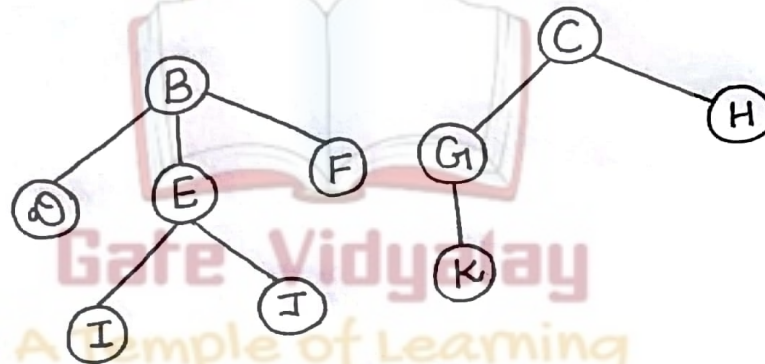
### • Example :





### 13. Forest:

- It is a set of disjoint trees.
- Example:



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