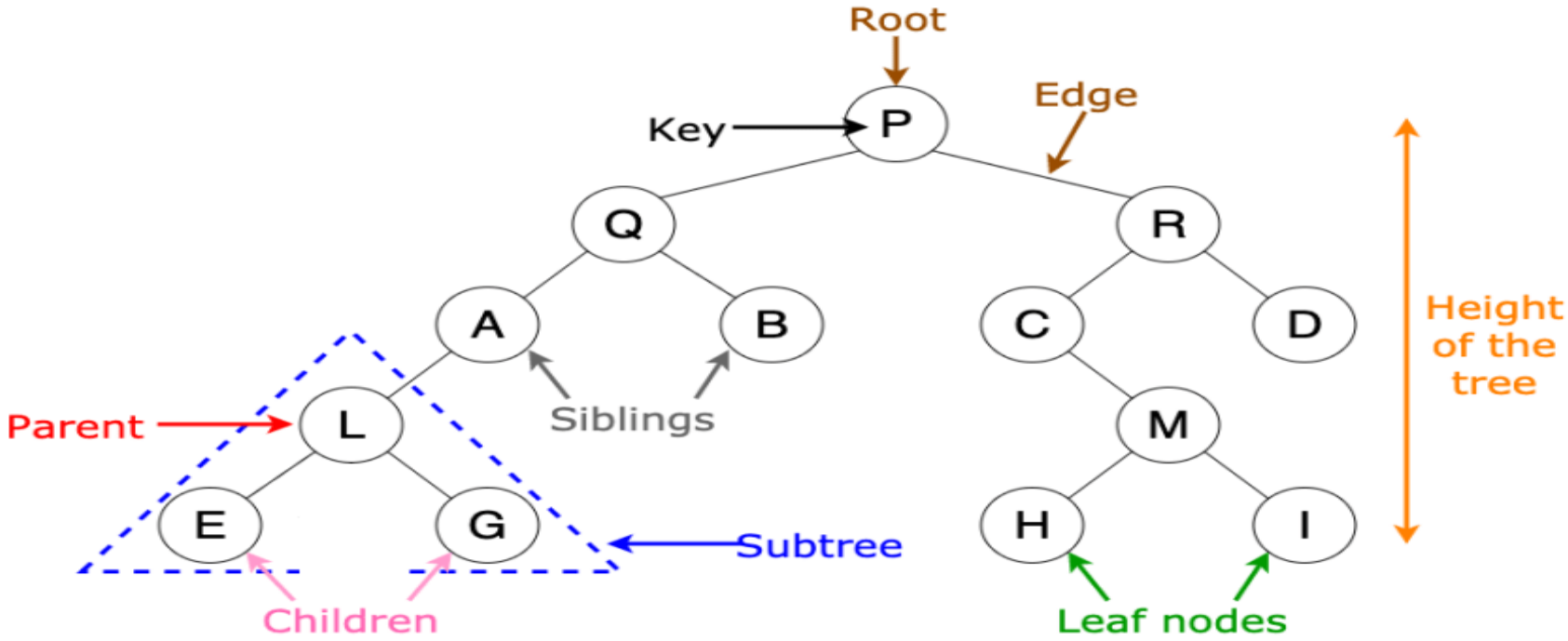
BINARY TREES

Binary Trees

- A **binary tree** is a hierarchical data structure in which each node has at most two children.



Examples of Binary Trees

Figure 1

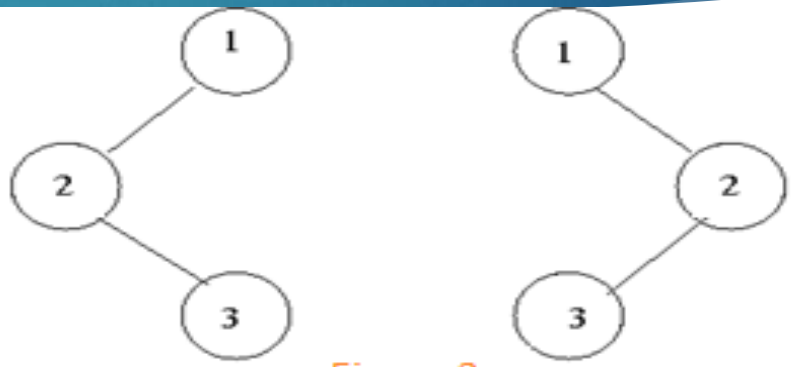


Figure 2

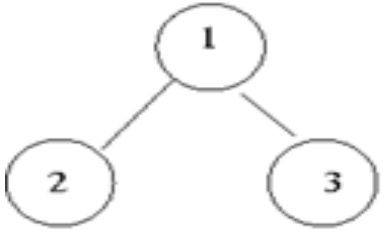


Figure 3

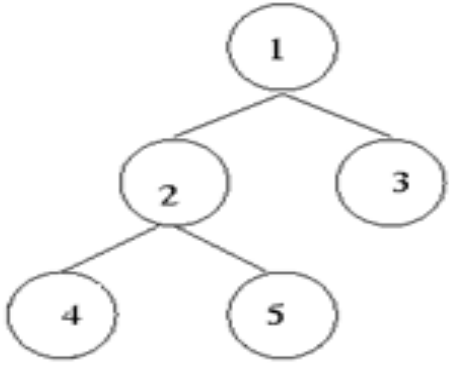


Figure 4

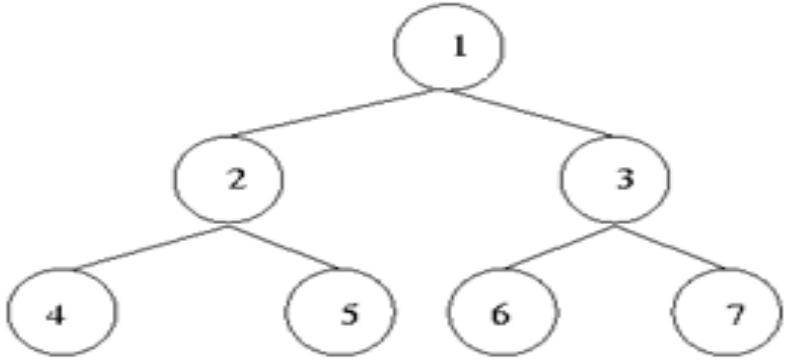


Figure 5

Properties of Binary Trees

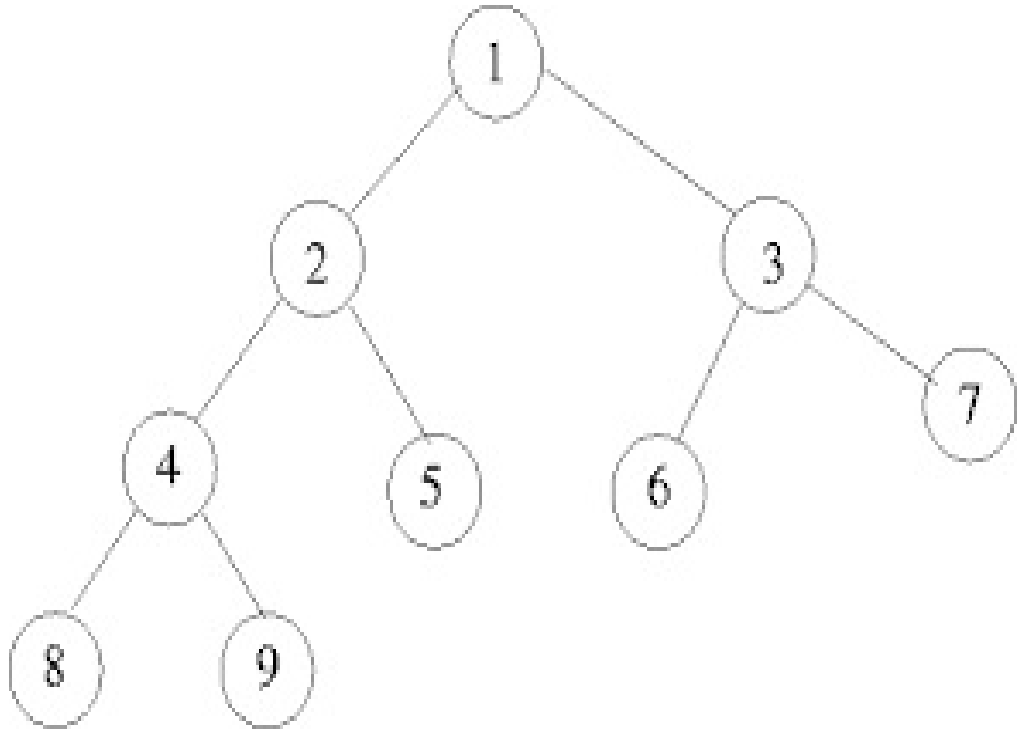
- Number of internal nodes = (Leaf node-1)

In this figure: Leaf node =5

So, Internal node = (Leaf node -1)

= (5-1)

= 4



Total number of nodes = (2 * Internal node)+1

Example: If the leaf node is 5 then how many nodes exist in the tree ?

Leaf node = 5

Internal nodes = (Leaf node-1)

= 4

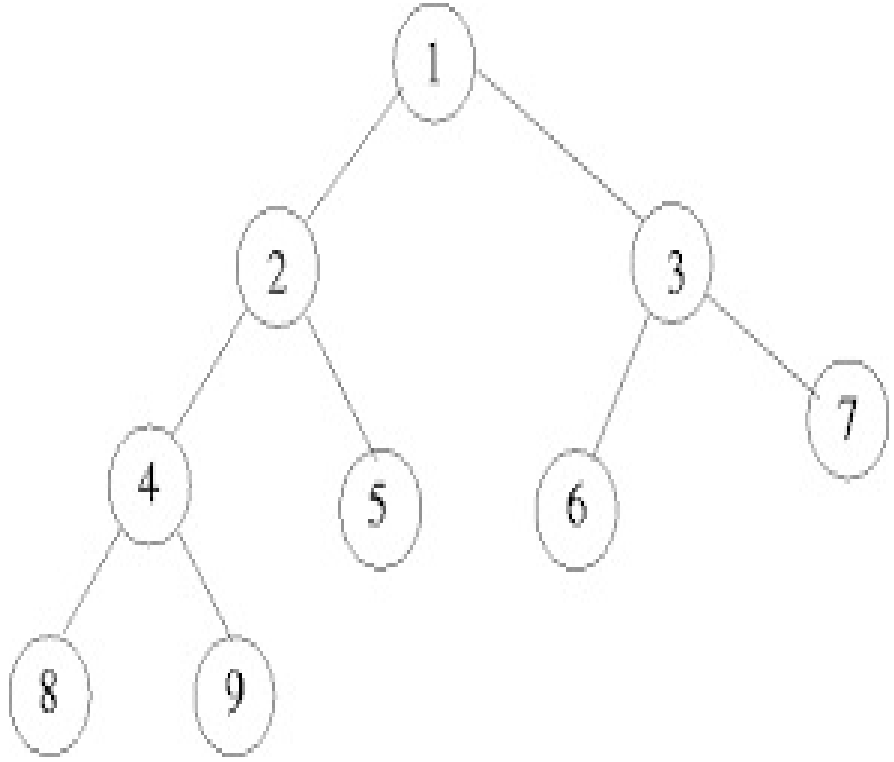
So , Total number of nodes = (2*Internal nodes)+1

= (2*4)+1

= 9

Hence,

Total number of nodes =9



Maximum number of nodes at any level 'L' = 2^L

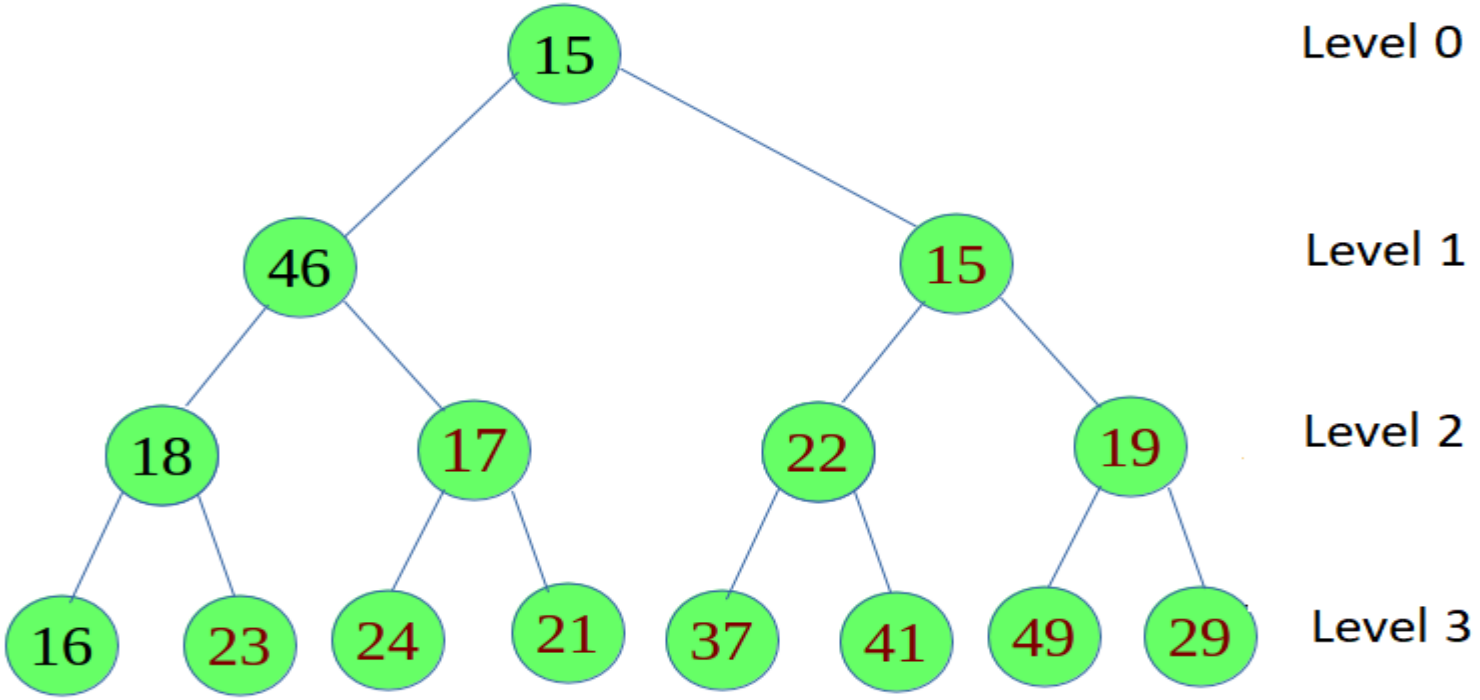
- At Level 0 , Nodes = 2^0

  At Level 1, Nodes = 2^1

  At Level 2, Nodes = 2^2

  At Level 3, Nodes = 2^3

  At Level L, Nodes = 2^L



Maximum number of nodes = $2^{H+1} - 1$

where H is the height of the tree

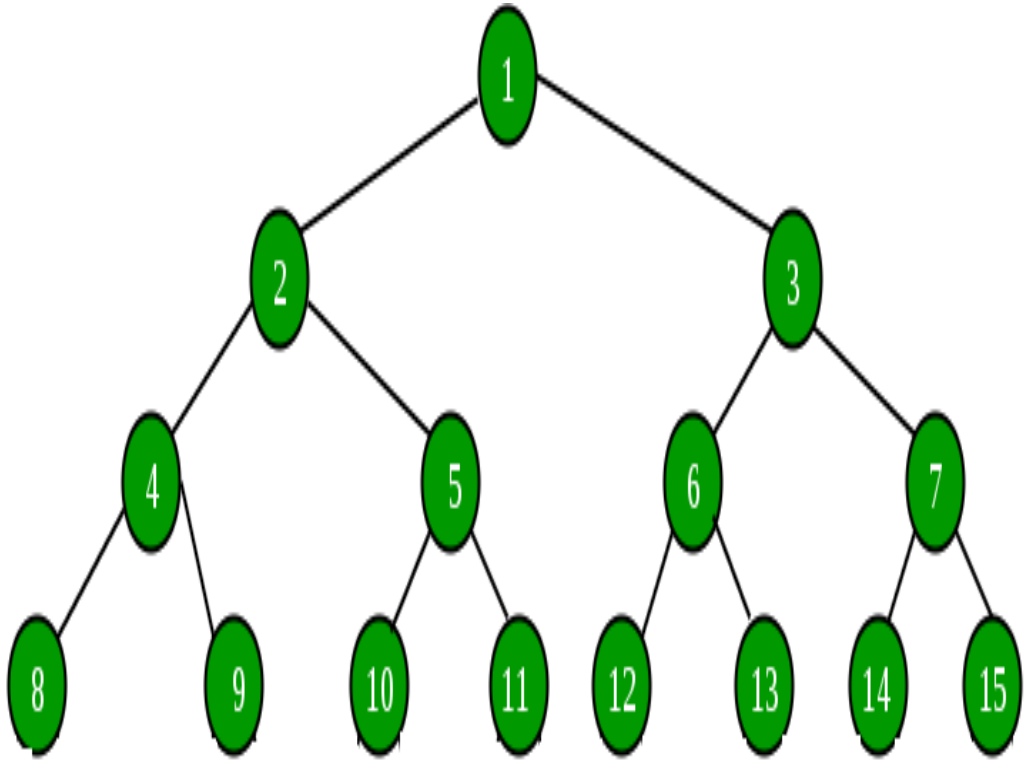
Example: If height of the tree is three then find the maximum number of nodes.

Height, H=3

Maximum number of nodes = $2^{H+1} - 1$

$= 2^{3+1} - 1$

$=15$



Minimum number of nodes = H+1

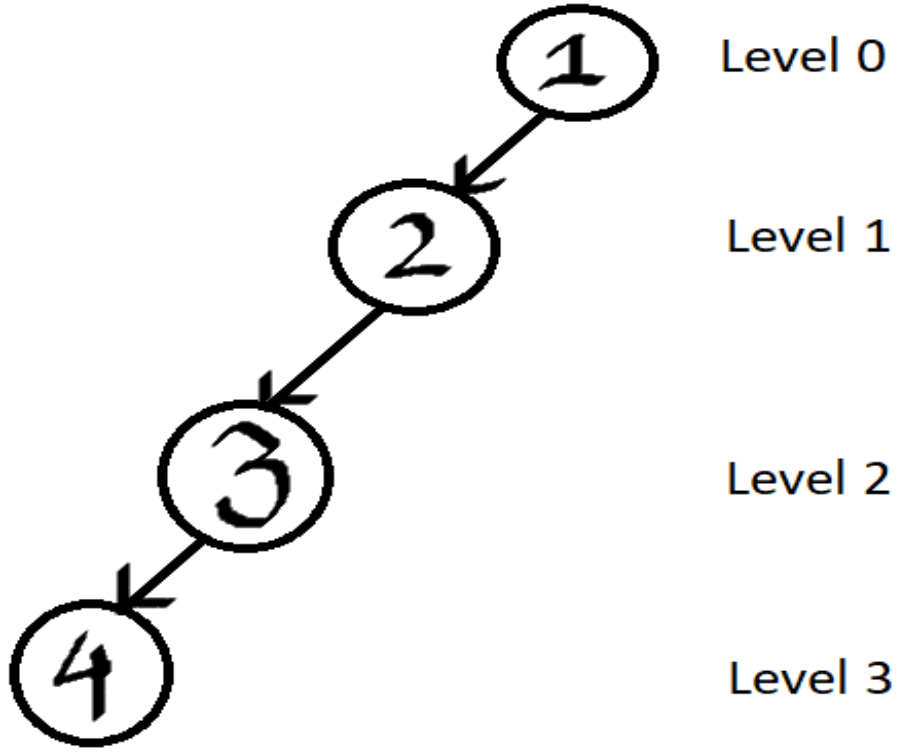
Example: If height of the tree is three then find the minimum number of nodes.

Height, H =3

Minimum number of nodes = H+1

= 3+1

= 4



Full Binary Tree

- A binary tree is a full binary tree if every node has zero or two children.

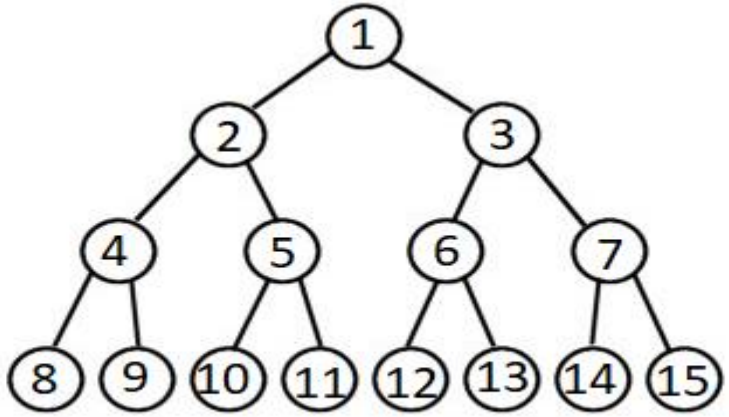


Figure 1

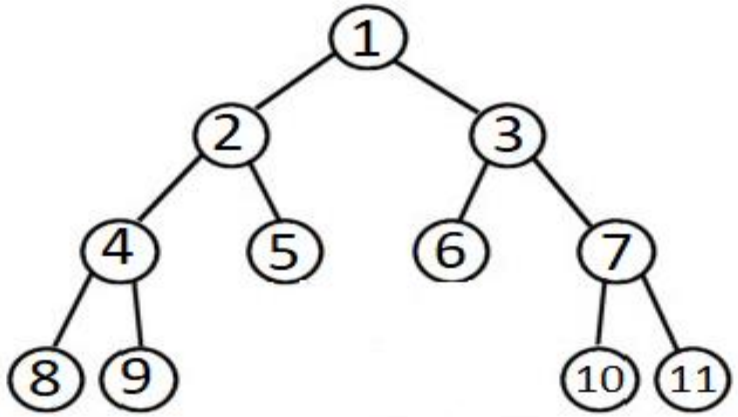


Figure 2

Complete Binary Tree

- A binary tree is a complete binary tree if all the levels are completely filled except possibly the last level.

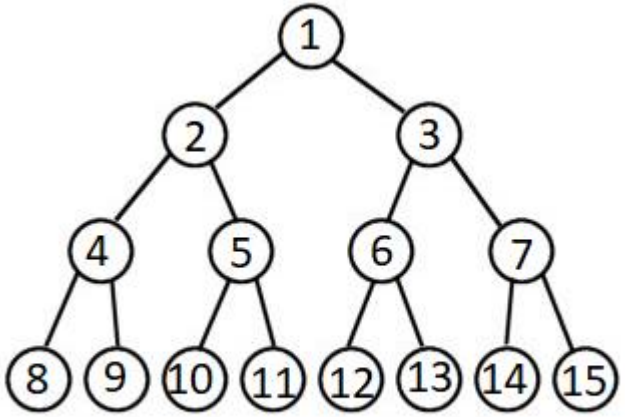


Figure 1

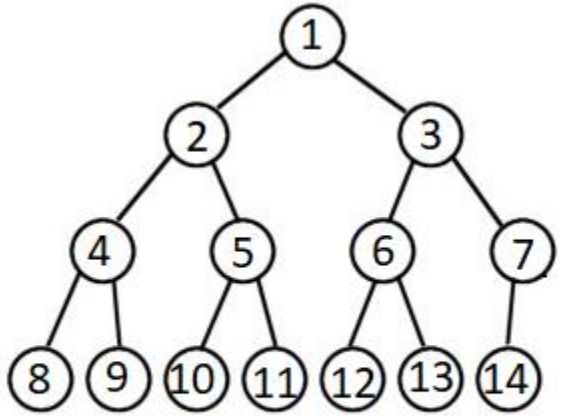


Figure 2

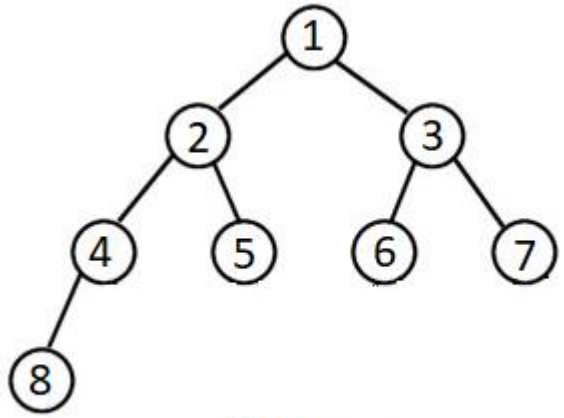
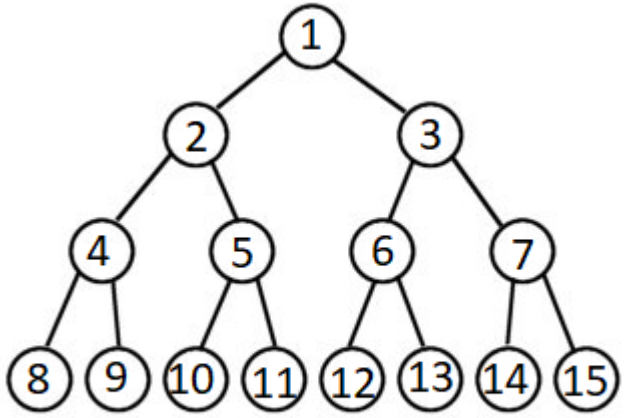


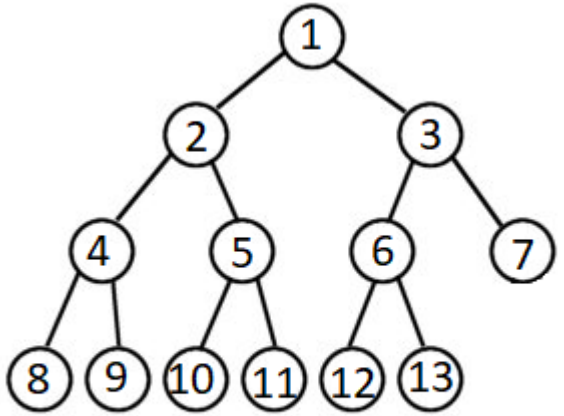
Figure 3

Perfect Binary Tree

- A binary tree is a perfect binary tree in which all the internal nodes have two children and all leaf nodes are at same level.



Perfect Binary Tree



Not Perfect Binary Tree

Degenerate Binary Tree

- A binary tree is a degenerate binary tree where for each parent node, there is only one associated child node.

Left Skewed Tree

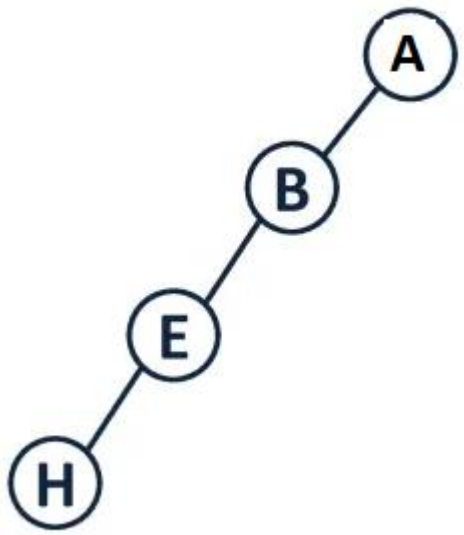


Figure 1

Right Skewed Tree

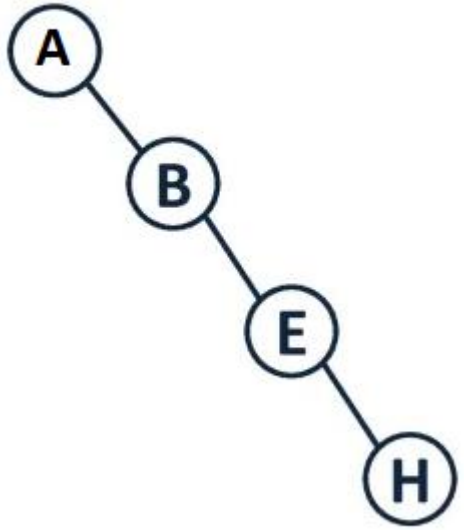


Figure 2

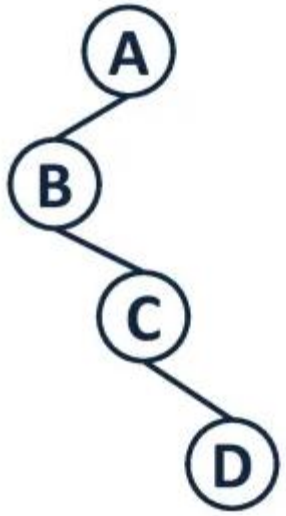


Figure 3