**MANIPAL UNIVERSITY JAIPUR**
*(University under Section 2(f) of the UGC Act)*

**B.TECH. SECOND YEAR**

**(III SEM. CSE/IT/CCE)**

**ACADEMIC YEAR: 2020-2021**

# COURSE NAME: ENGINEERING MATHEMATICS III

COURSE CODE : MA 2101

LECTURE SERIES NO : UNIT-III (LECTURE NO. 14- 22)

CREDITS : 3

MODE OF DELIVERY : ONLINE (POWER POINT PRESENTATION)

FACULTY : DR. REEMA JAIN

EMAIL-ID : reema.jain@jaipur.manipal.edu

PROPOSED DATE OF DELIVERY: August 17, 2020

**MANIPAL UNIVERSITY JAIPUR**

**VISION**
Global Leadership in Higher Education and Human Development

**MISSION**
• Be the most preferred University for innovative and interdisciplinary learning
• Foster academic, research and professional excellence in all domains
• Transform young minds into competent professionals with good human values

**VALUES**
Integrity, Transparency, Quality,
Team Work, Execution with Passion, Humane Touch

# SESSION OUTCOME

*"TO UNDERSTAND THE CONCEPT OF TREES AND APPLY THE TREE ALGORITHMS TO ANALYZE THE SHORTEST PATH PROBLEMS"*

# ASSESSMENT CRITERIA

ASSIGNMENT

QUIZ

MID TERM EXAMINATION –I  & II
END TERM EXAMINATION

# PROGRAM OUTCOMES MAPPING WITH CO3

**ENGINEERING KNOWLEDGE: APPLY THE KNOWLEDGE OF MATHEMATICS, SCIENCE, ENGINEERING FUNDAMENTALS, AND AN ENGINEERING SPECIALIZATION TO THE SOLUTION OF COMPLEX ENGINEERING PROBLEMS.**
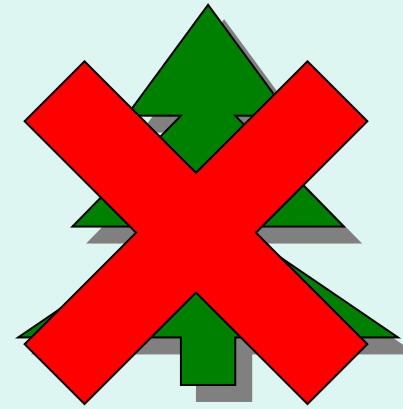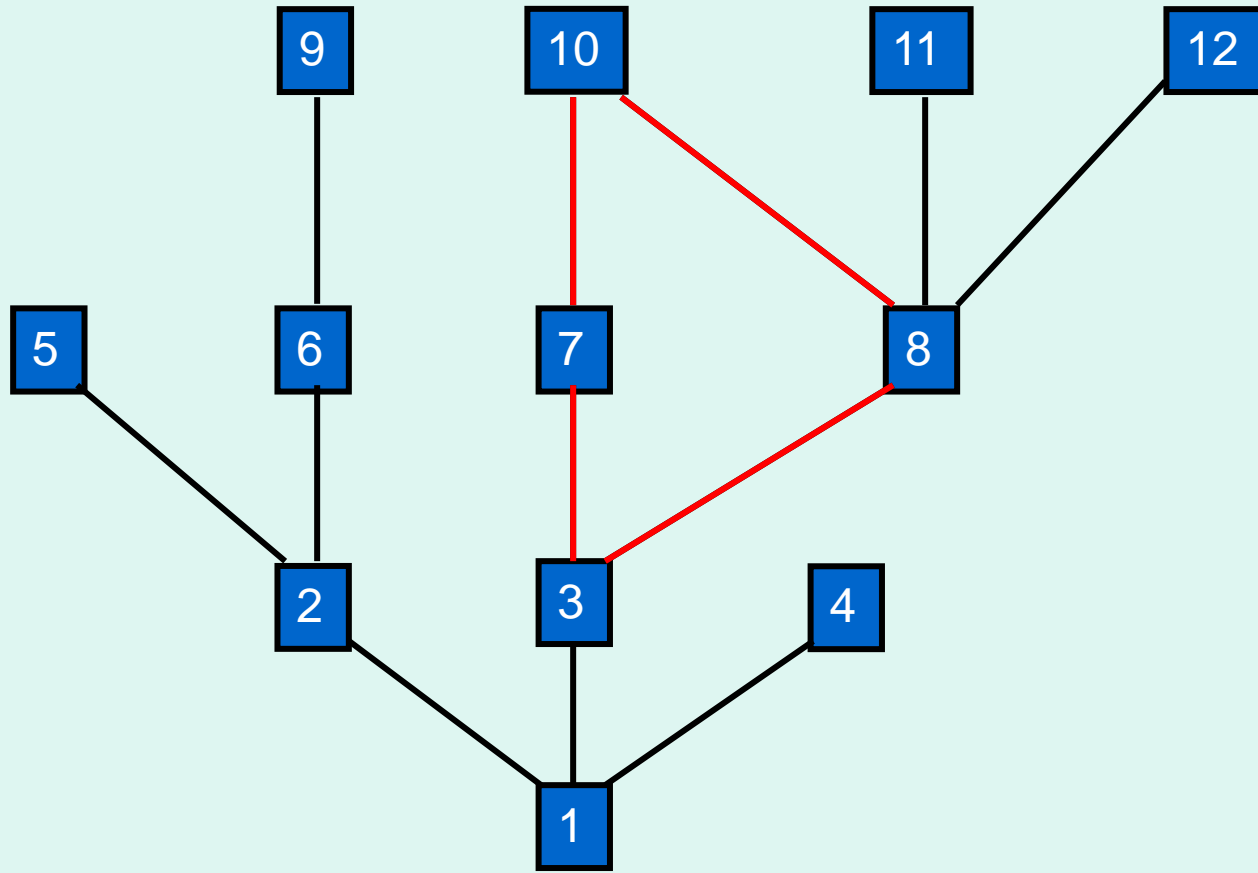
# Trees

Definition: A *tree* is a connected undirected graph with no cycles. In other words a *tree* T is a simple graph such that for every pair of vertices v and w there is a unique path from v to w.

When talking about graphs, we say a tree is a graph that is:
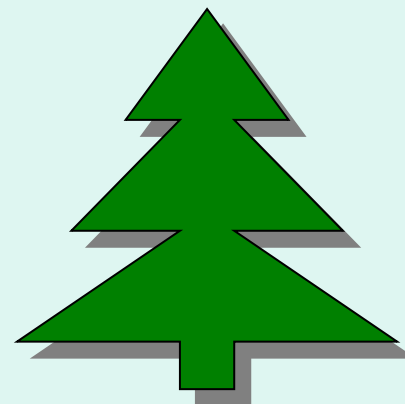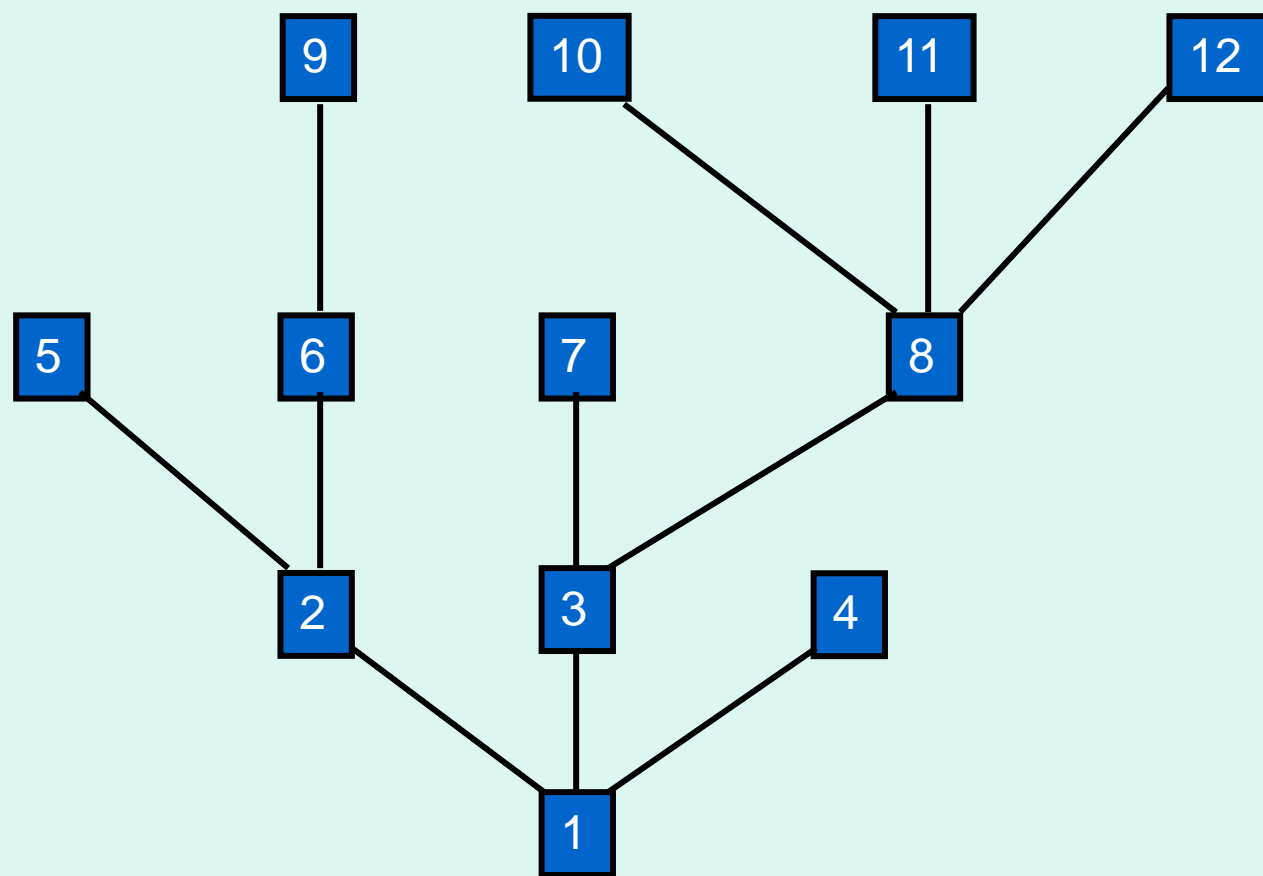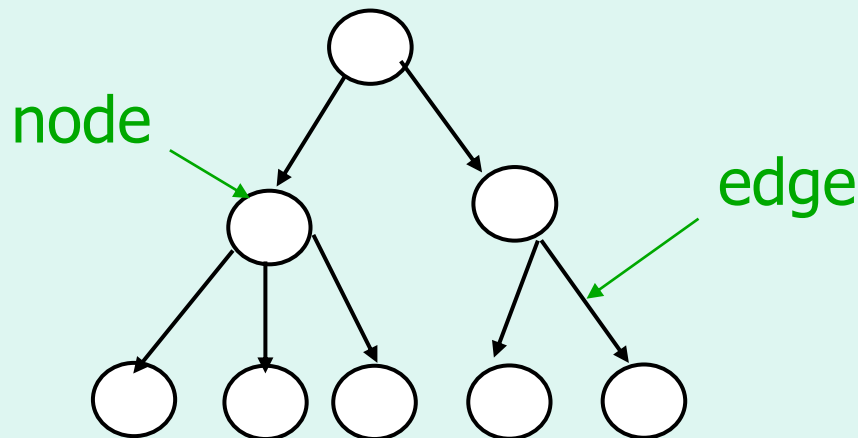- undirected
- acyclic
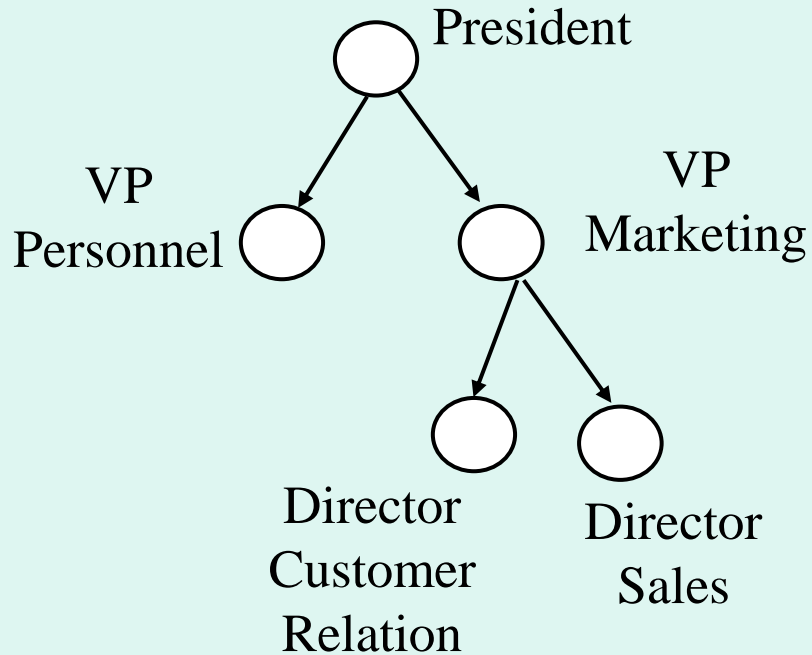- Connected.
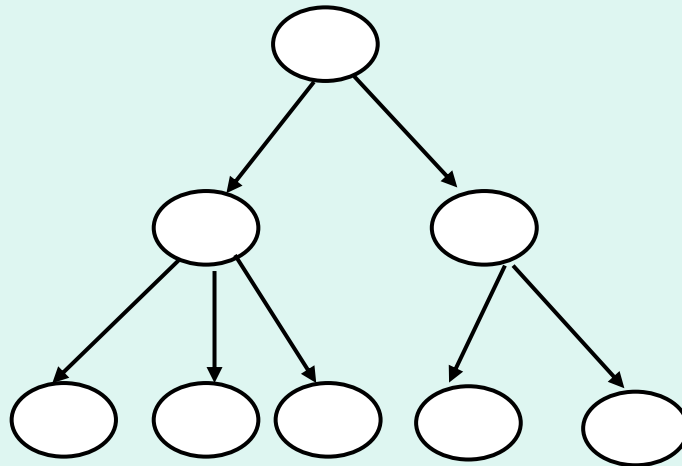
# A Tree?

# A Tree?

# Facts about Trees

- All trees are graphs, but NOT all graphs are trees.
- An undirected graph is a tree if and only if there is a unique simple path between any two of its vertices.
- Trees are structures used to represent hierarchical relationship.
- Each tree consists of nodes and edges.
- Each node represents an object.
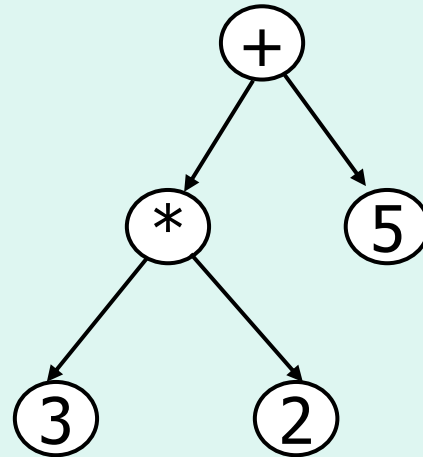- Each edge represents the relationship between two nodes.

node

edge

# Some Applications of Trees

## Organization Chart

President

VP Personnel

VP Marketing

Director Customer Relation

Director Sales

## Expression Tree

$+$

$*$

$5$

$3$

$2$

**Applications of trees:**
- Represent organization
- Represent computer file systems
- Networks to find best path in the Internet
- Chemical formulas representation etc.

# Certain Properties of Trees

Theorem 1: A graph G is a tree if and only if there is a unique simple path between any two vertices of G.

Theorem 2: Every tree, T = (V, E) with |V|≥2, has at least two vertices that have degree = 1.

Theorem 3: Every tree with n vertices has exactly n−1 edges.

*(Questions based in above theorems)*

# Basic Terminology I

- For any two nodes u and v, if there is an edge pointing from u to v, u is called the parent of v while v is called the child of u. Such edge is denoted as (u, v).

- In a tree, there is exactly one node without parent, which is called the root. The nodes without children are called leaves.

root

u: parent of v
v: child of u
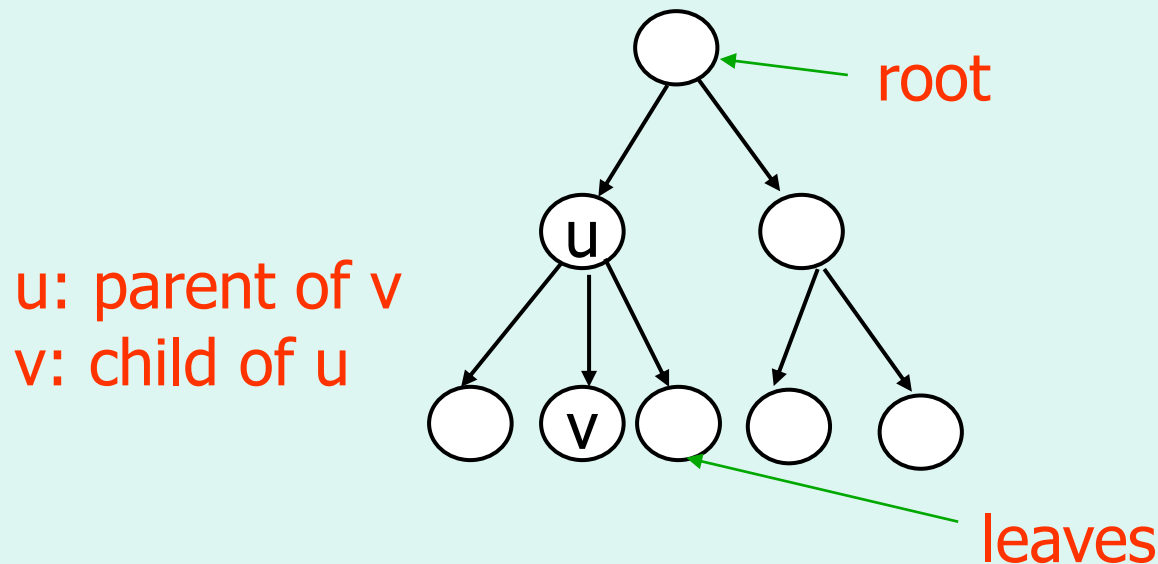
leaves

# Basic Terminology II

- In a tree, the nodes without children are called leaves. Otherwise, they are called internal nodes.
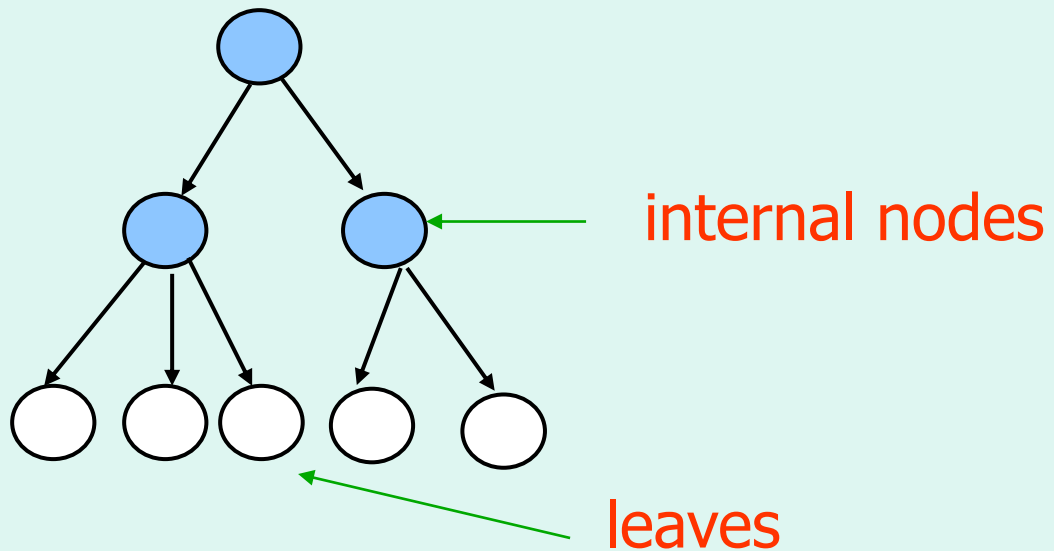
# Basic Terminology III

- If two nodes have the same parent, they are siblings.

- A node u is an ancestor of v if u is parent of v or parent of parent of v or …

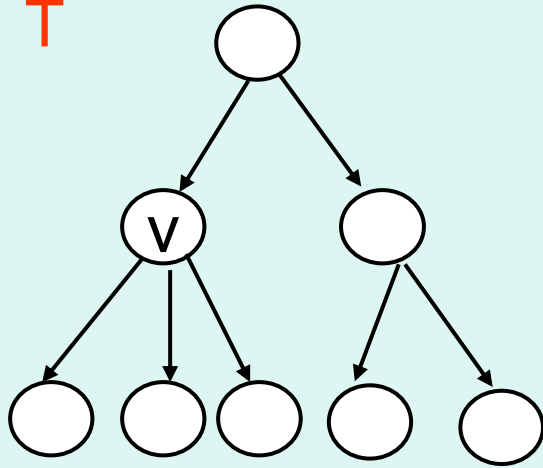- A node v is a descendent of u if v is child of v or child of child of v or …

v and w are siblings
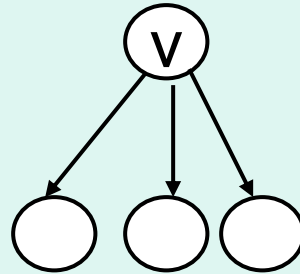u and v are ancestors of x
v and x are descendants of u
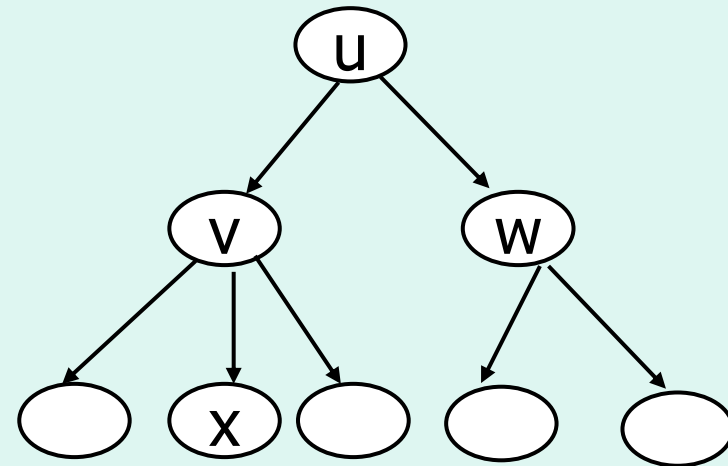
# Basic Terminology IV

- A subtree is any node together with all its descendants.

# Basic Terminology V

- Level of a node n: number of nodes on the path from root to node n
- Height of a tree: maximum level among all of its node
- *Depth of a vertex*  v  is its distance from the root.



**height=4**

Level 1

Level 2

Level 3

**n**

Level 4