Data Structures

Introduction to Graphs
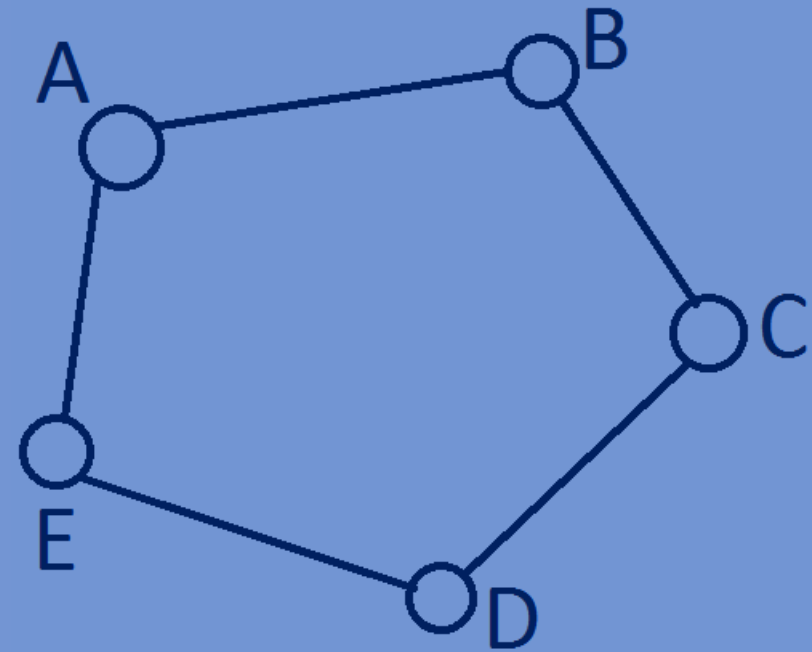
What is a graph???

- A graph 'G' is collection of vertices 'V' and edges 'E' => a graph is a pair of sets(V,E)

  G=(V,E)

  V={A,B,C,D,E}

  E={(A,B),(B,C),(C,D),(D,E),(E,A)}

- A graph is a collection of objects called as nodes and these nodes are connected to each other through edges.

Graph terminology:

Edge:-Edge is the connecting link between two vertices of a graph,edge is represented
As (origin vertex,destination vertex),for example in the below figure the connection
Between two nodes(A and B) is represented by (A,B).

$E=\{(A,B),(B,C),(C,D),(D,E),(E,A)\}$
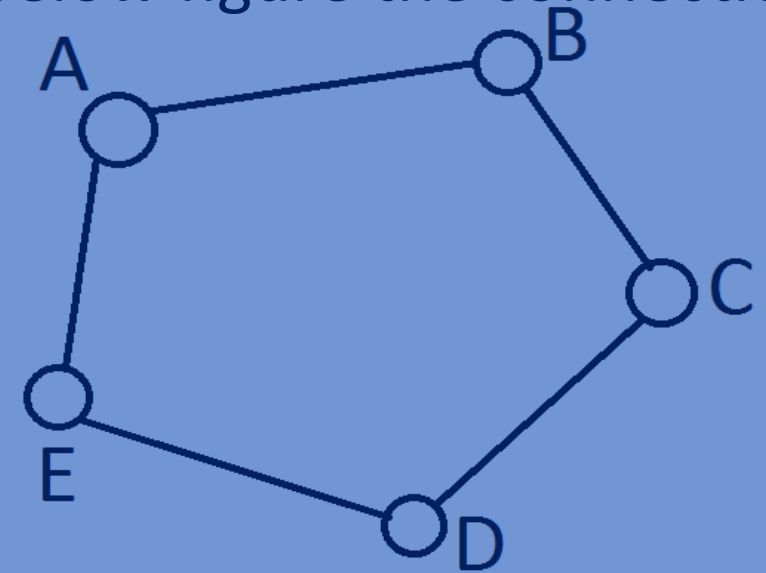
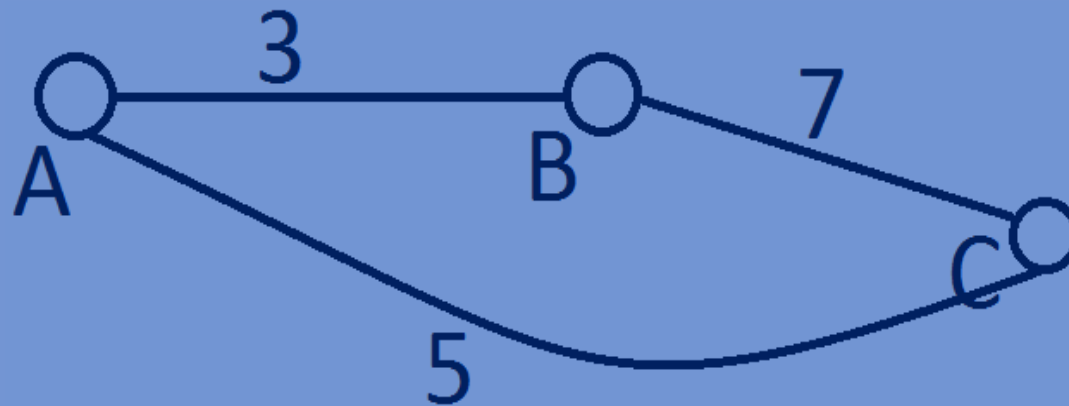**Directed Edge:**A directed edge has connection only in
one direction which means it is unidirectional. If there is an directed edge from A to
B,then we can that there is path between A and B,but we cant say that there is a path
between B and A.Here edge (A,B)!=(B,A)

Undirected Edge: An undirected edge has connection in both directions which means it is bidirectional.If there is an undirected edge from A to B,then we can say that there is a path between vertices A and B as well as B and A.Here (A,B)=(B,A).
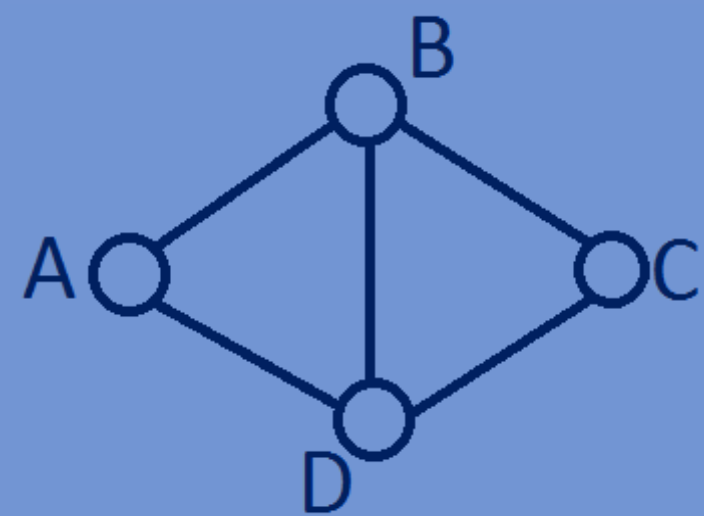

Weighted Edge:A weighted edge is an edge having some weight on it,weight of an Edge is often referred as "cost" of the edge.In applications weight of an edge Represents length of a route,capacity of a line etc.

Directed Graph:A Graph with all directed edges is called as a Directed Graph.
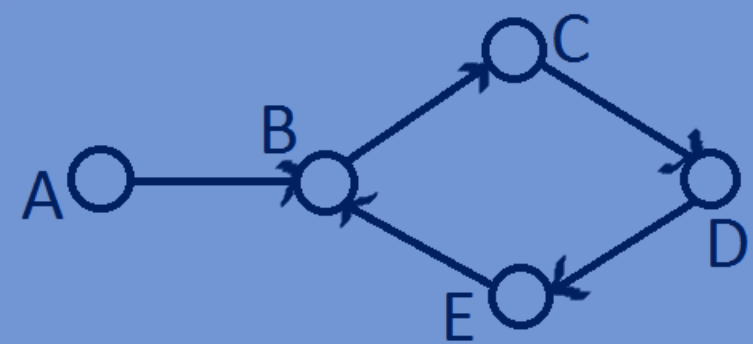
Undirected Graph:A Graph with all undirected edges is called as Undirected Graph.

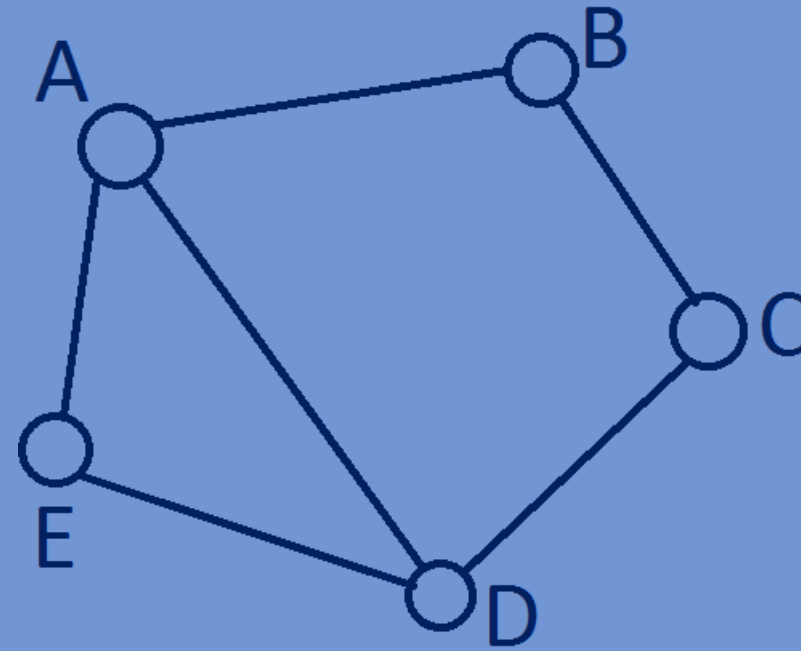**Degree of a Node:**Total no of edges connected to a vertex is called as Degree of That vertex.

     Degree(A)=3
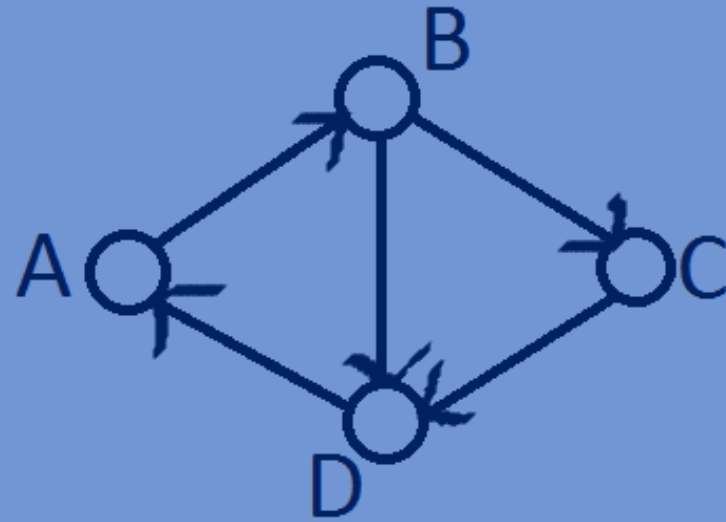
     Degree(B)=2

     Degree(C)=2

     Degree(D)=3

     Degree(E)=2

● For a directed graph each vertex has indegree and outdegree.

Indegree: The total no of incoming edges of a vertex is called as indegree of the vertex.

Outdegree: The total no of Outgoing edges of a vertex is called as outdegree of the vertex.

Indegree(A)=1,Outdegree(A)=1

Indegree(B)=1,Outdegree(B)=2

Indegree(C)=1,Outdegree(C)=1

Indegree(D)=2,Outdegree(D)=1

Difference between Tree and Graph:

- Tree is a special form of graph that have only one path between any two nodes, But a graph can have more than one path between any two nodes.
- A tree doesn't have any loops or circuits,but a graph can have loops and circuits.
- In a tree every node can have at most two children, but in a graph a node can Have any no of connections to other nodes.
- Trees are categorised into binary trees,Binary search trees,AVL Trees,Heaps etc But graphs are only of two types->directed and undirected graphs.
- Tree has a hierarchal structure whereas a graph has network structure.
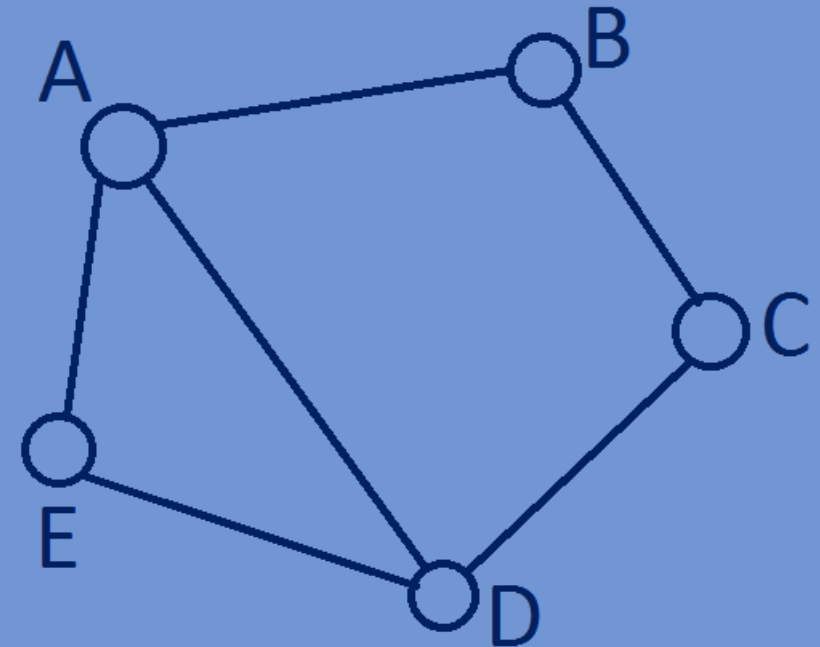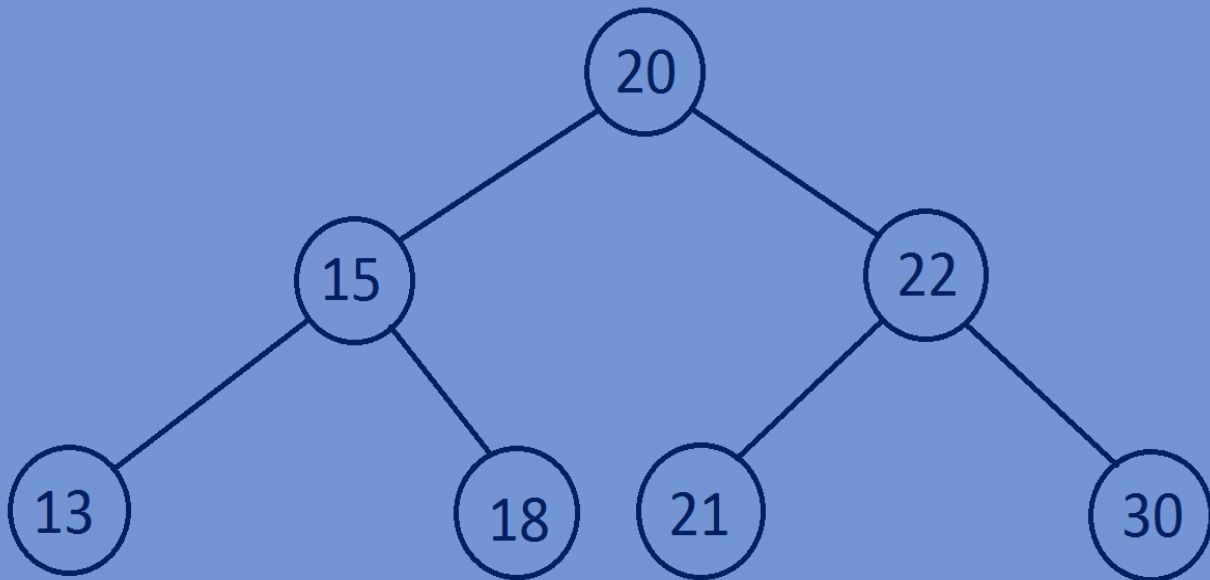
Applications of Graphs:

- Graphs are used to represent network communication,data organisation and computational devices.
- In mathematics graphs are used in geometry.
- Some graph algorithms are used to find the shortest distance between two points.
- Graphs are used in maps to find shortest,cheapest path between two cities .
- Facebook is based on graphs here each user is represented by a vertex and if two Vertices are connected by an edge that means these two users are friends
- Graph theory is used to study molecules in chemistry.
- Graphs are used to link web pages in internet.