GROUP ACTIVITY

GRAPH THEORY

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Topics

We will be covering today

01

Introduction

02

Kruskal's Algorithm

03

Prim's Algorithm

04

Dijkstra's Algorithm

What Is Graph?

In math, a graph can be defined as a pictorial representation or a diagram that represents data or values in an organized manner.
The points on the graph often represent the relationship between two or more things.

Important Terms

Vertices

Also known as Nodes

Node is one of the points on which the graph is defined and which may be connected by graph edges.

Edges

Also known as Link

Edge is one of the connections between the nodes (or vertices) of the network.

Degree of Vertex

It can be of 2 types - Indegree and Outdegree

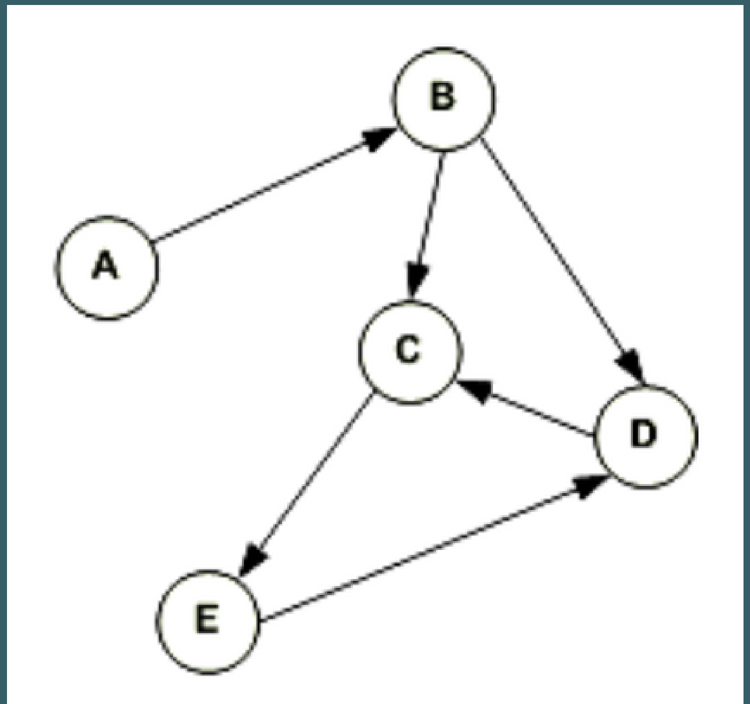
Degree - Number of vertices adjacent to a vertex V.
Indegree - Number of edges which are coming into the vertex V.
Outdegree - Number of edges which are going out from the vertex V.

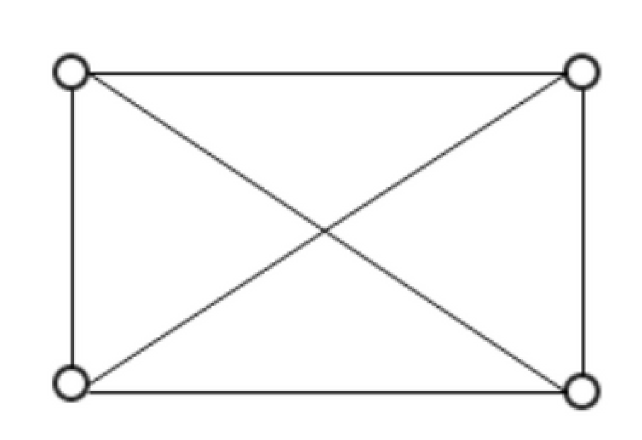
Types Of Graph

Undirected Graph - An undirected graph is a graph whose edges are not directed.

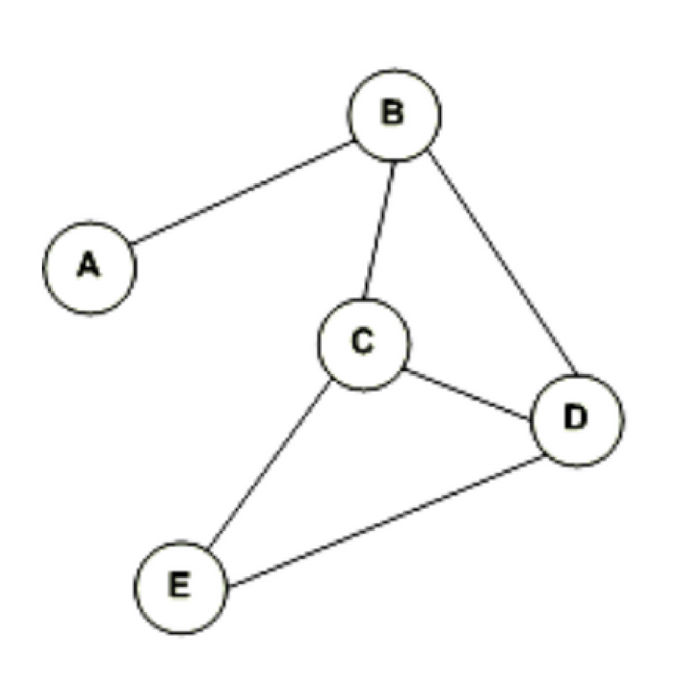
Directed Graph - A directed graph is a graph in which the edges are directed by arrows.

Simple Graph - A simple graph is the undirected graph with no parallel edges and no loops.

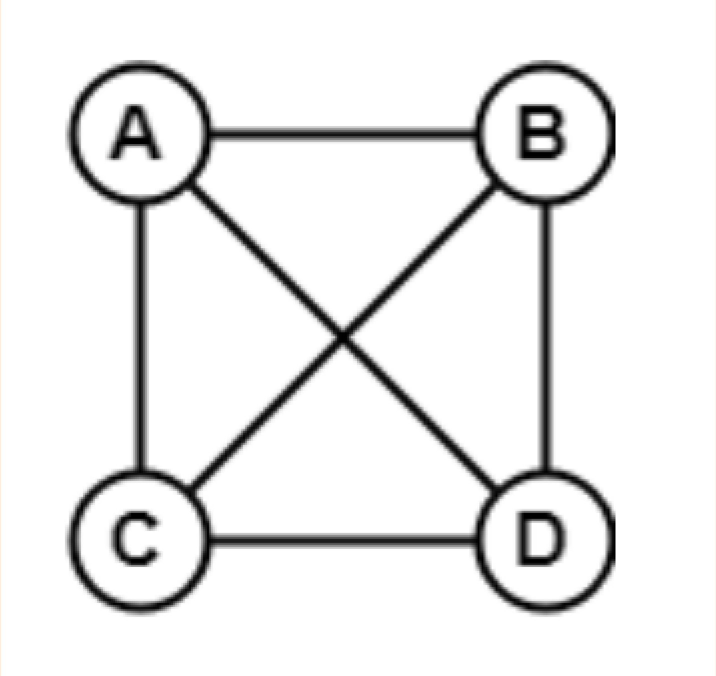




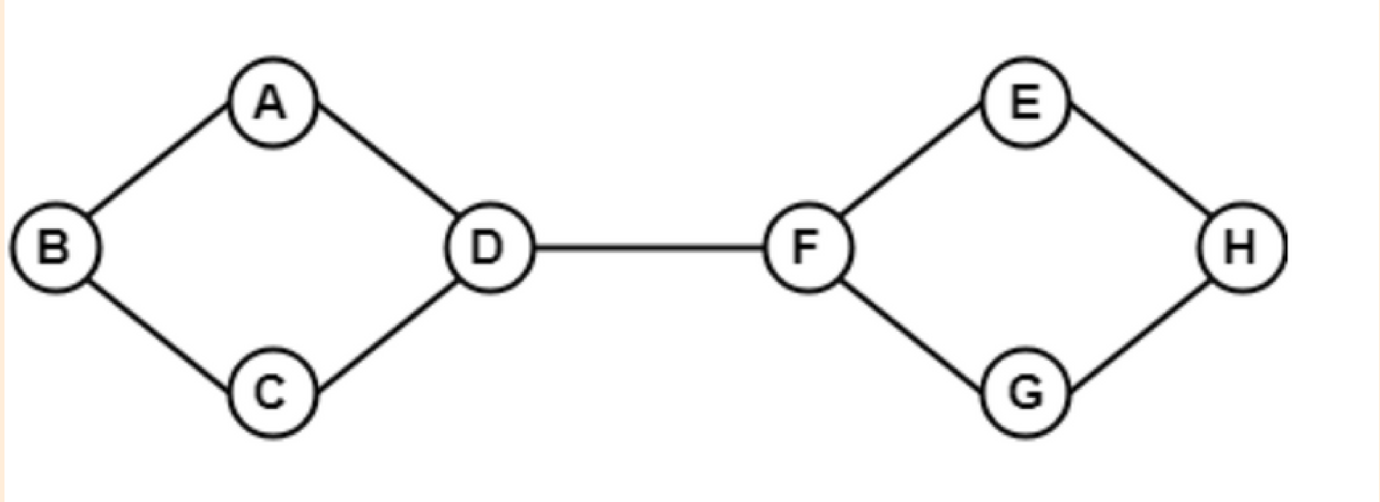
Simple Graph



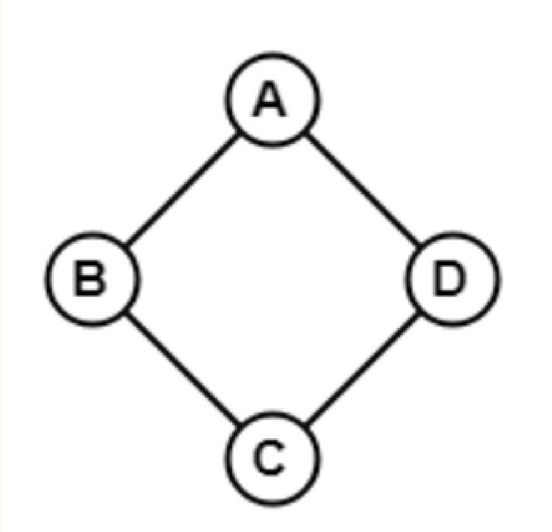
Complete Graph - A graph in which every pair of vertices is joined by exactly one edge is called complete graph



Connected Graph - A graph in which we can visit from any one vertex to any other vertex.



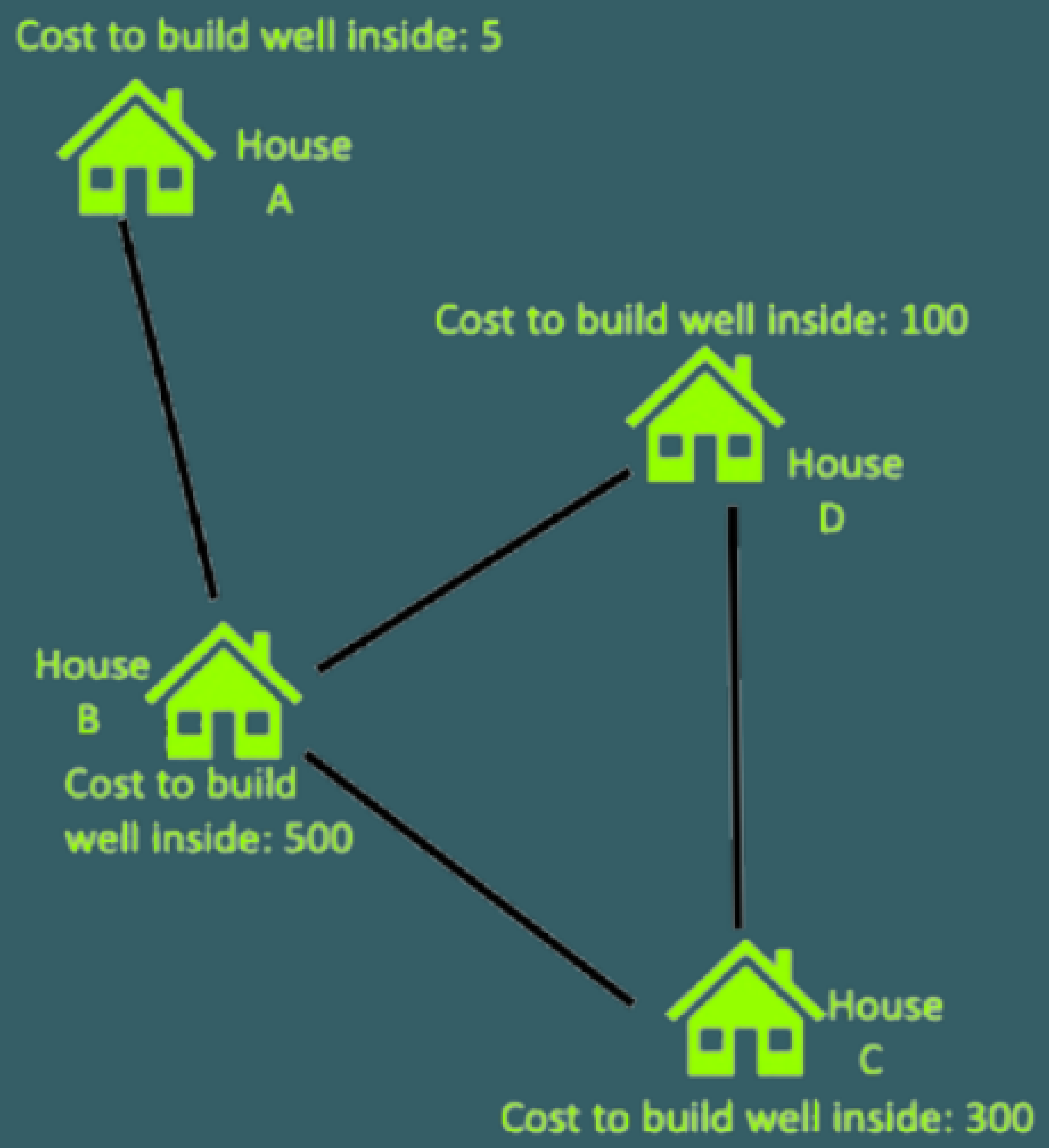
Disconnected Graph - A graph in which any path does not exist between every pair of vertices.



Kruskal's Algorithm

Definition:

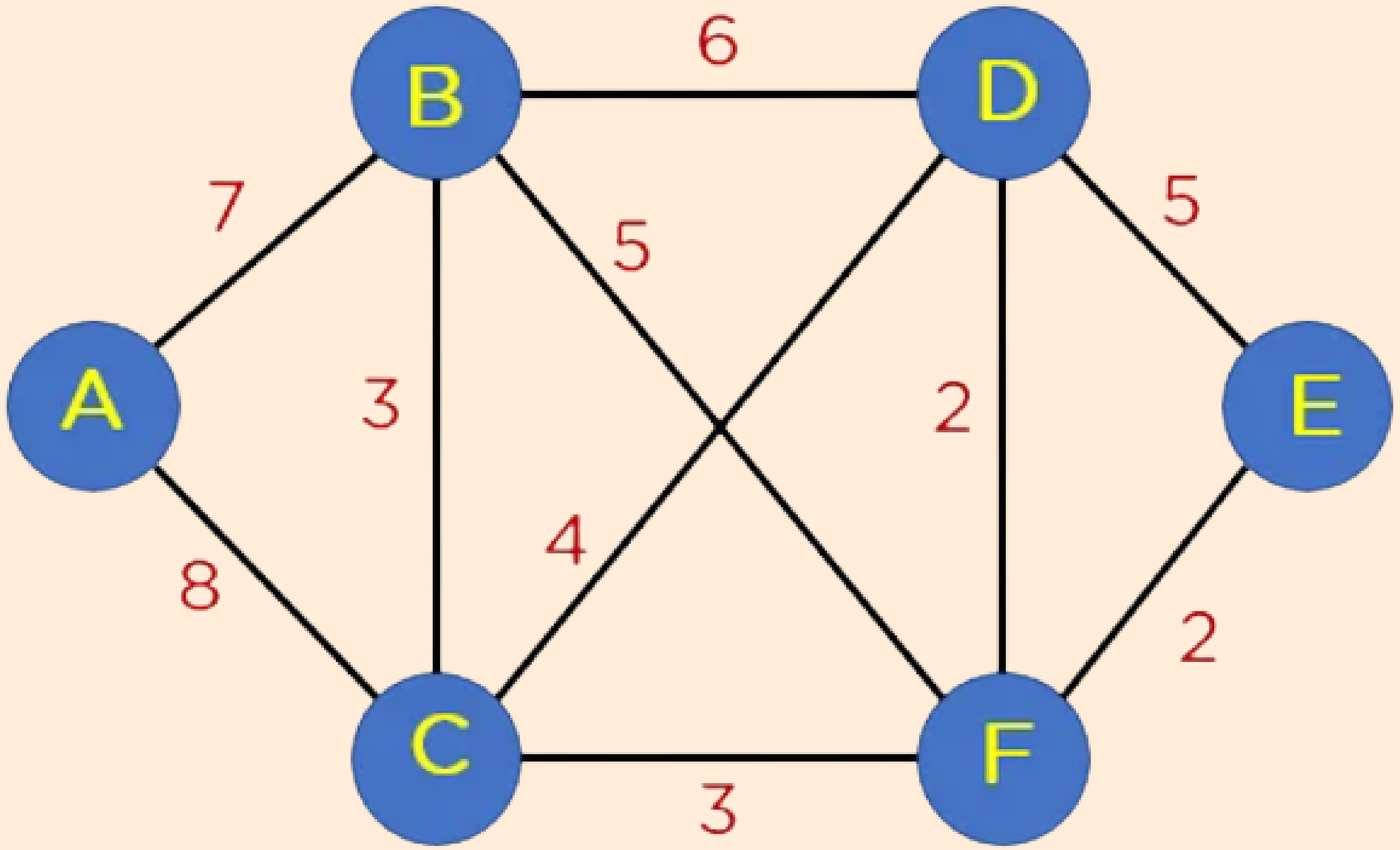
Kruskal's algorithm is a greedy algorithm that finds a minimum spanning tree for a connected weighted graph.



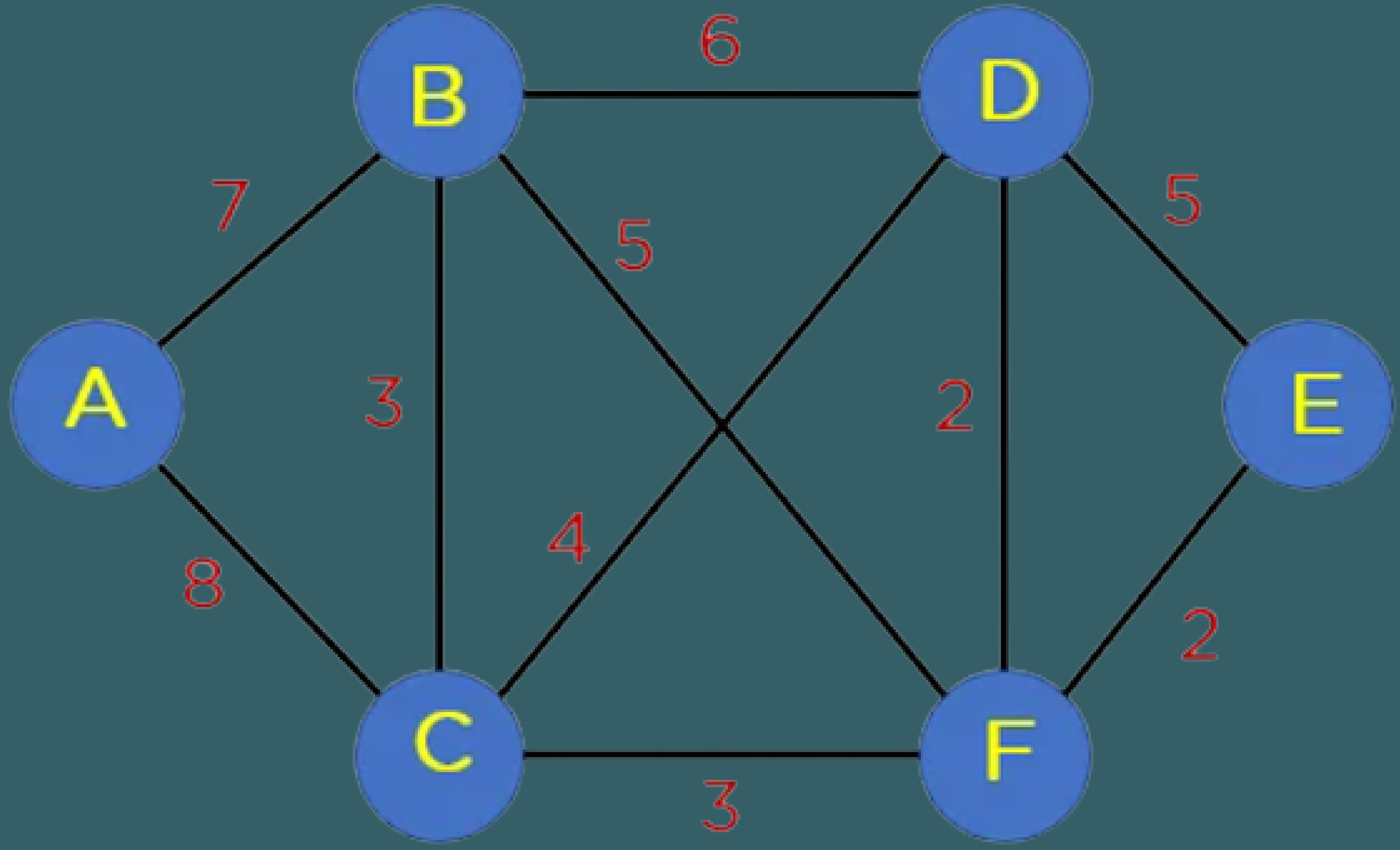
Minimum Cost to supply water to all houses :

5+10+20+30=65

Steps to find minimum spanning tree using **Kruskal's Algorithm**

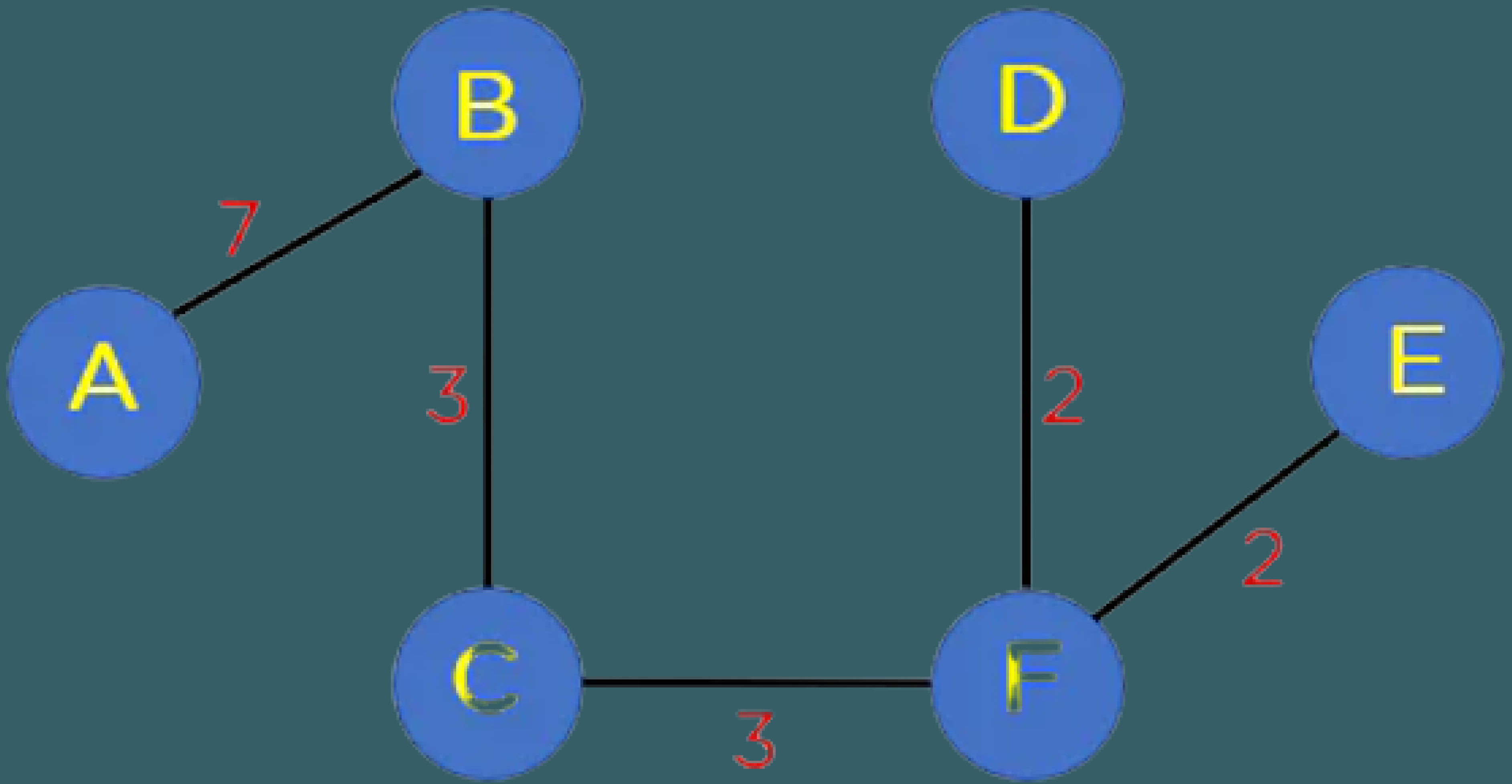


- *Step 1: Sort all edges in increasing order of their edge weights.*
- *Step 2: Pick the smallest edge.*
- *Step 3: Check if the new edge creates a cycle or loop in a spanning tree*
- *Step 4: If it doesn’t form the cycle, then include that edge in MST. Otherwise, discard it.*
- *Step 5: Repeat from step 2 until it includes |V| - 1 edges in MST.*



Removing Looping edges from graph as trees never include loops or parallel edges.

Here the summation of edges results in 17 which is the least possible edge weight for any mst for this graph.

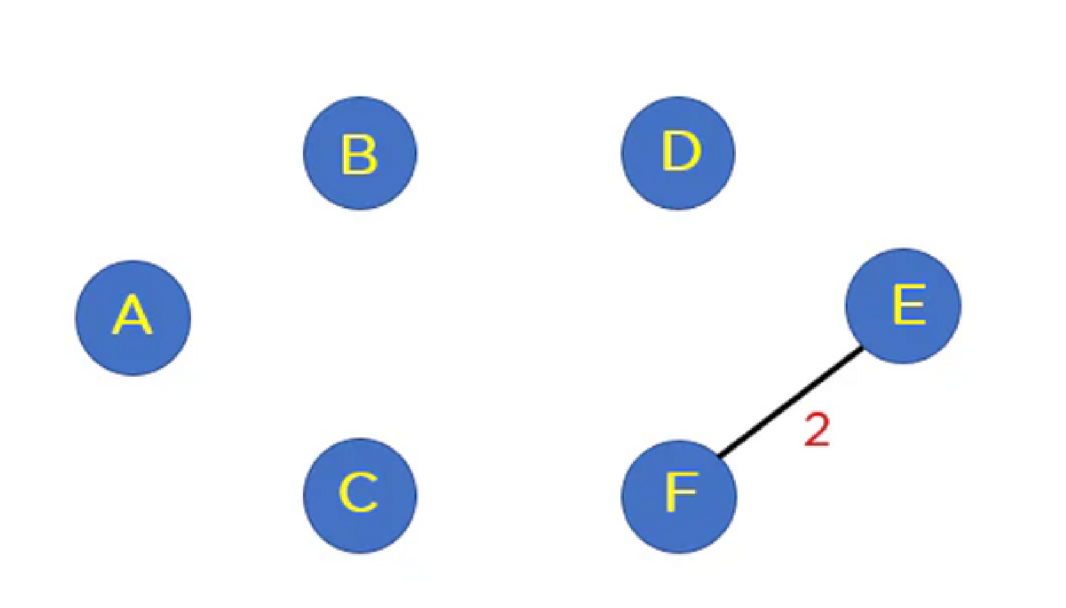


Minimum Spanning Tree.

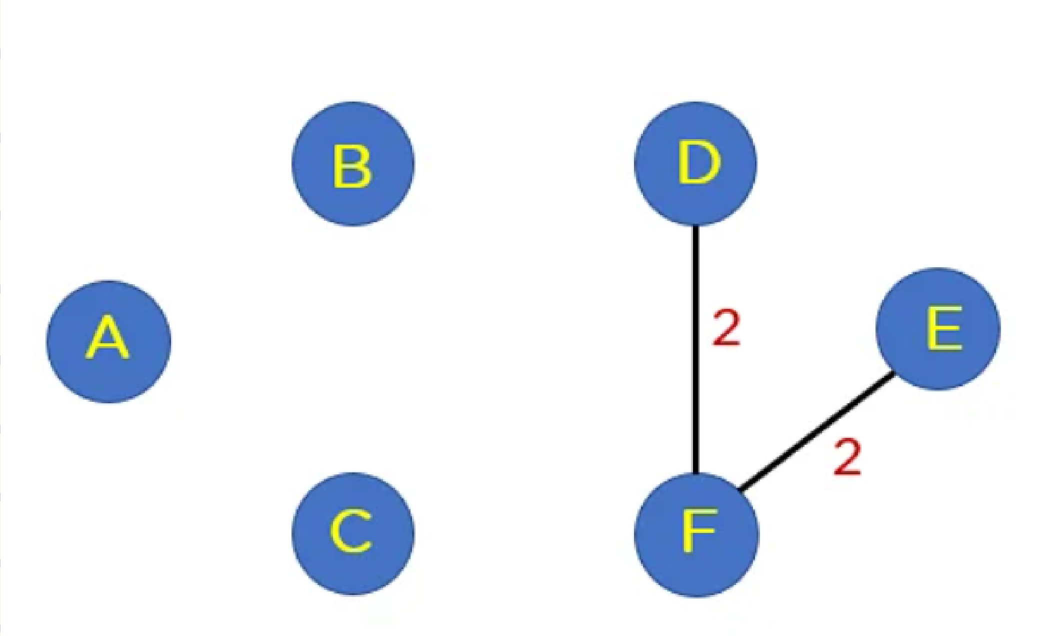
Step 1: Sort all edges in increasing order of their edge weights.

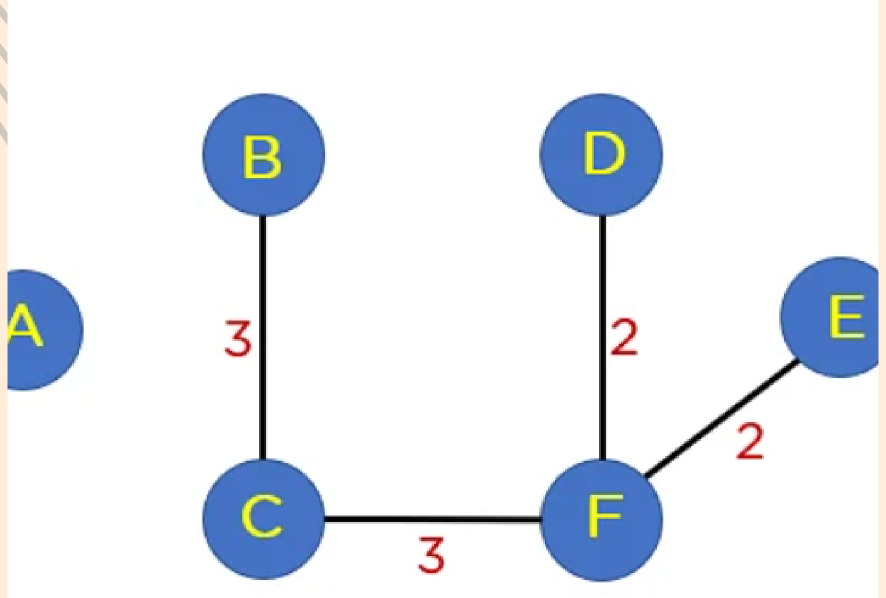
Source Vertex	Destination vertex	
E	F	2
F	D	2
B	C	3
C	F	3
C	D	4
B	F	5
B	D	6
A	B	7
A	C	8

Step 2: Pick the smallest edge.

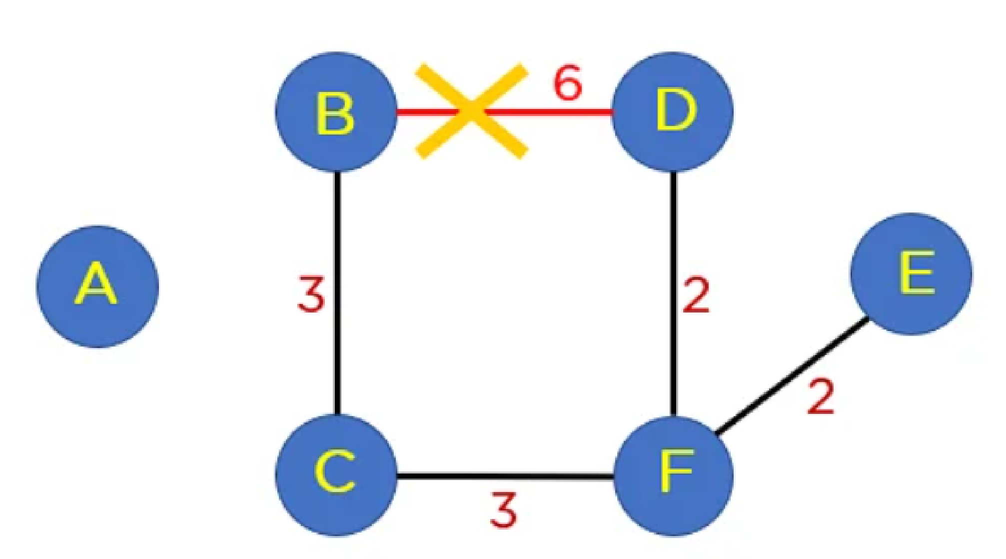


STEP 3 :edge EF, as it has a minimum edge weight that is 2. and doesnt form a loop

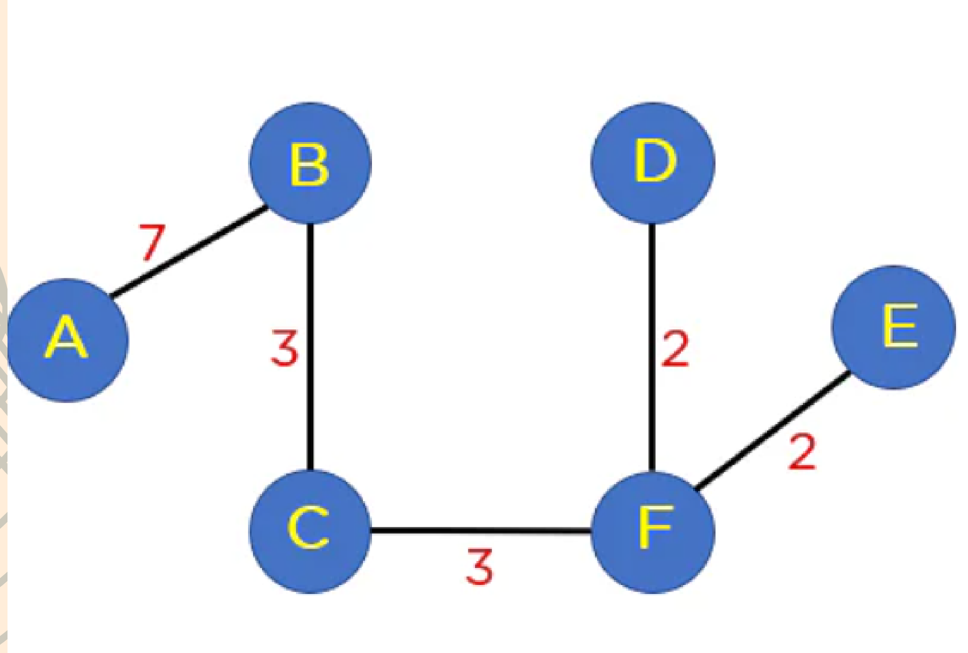




Add edge BC and edge CF to the spanning tree as it does not generate any loop.



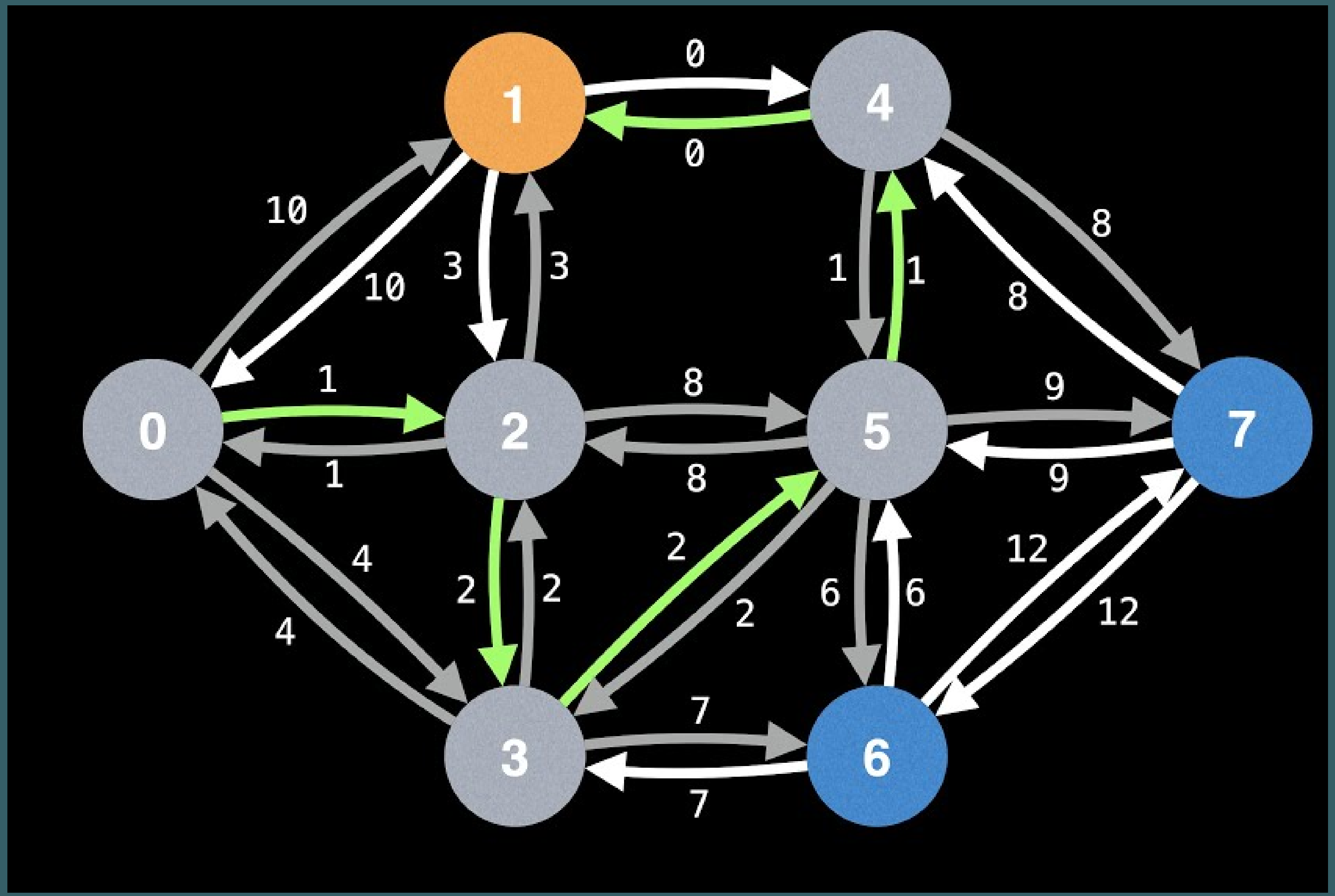
Discarding edges CD,BF and BD as they formulate loops in graph



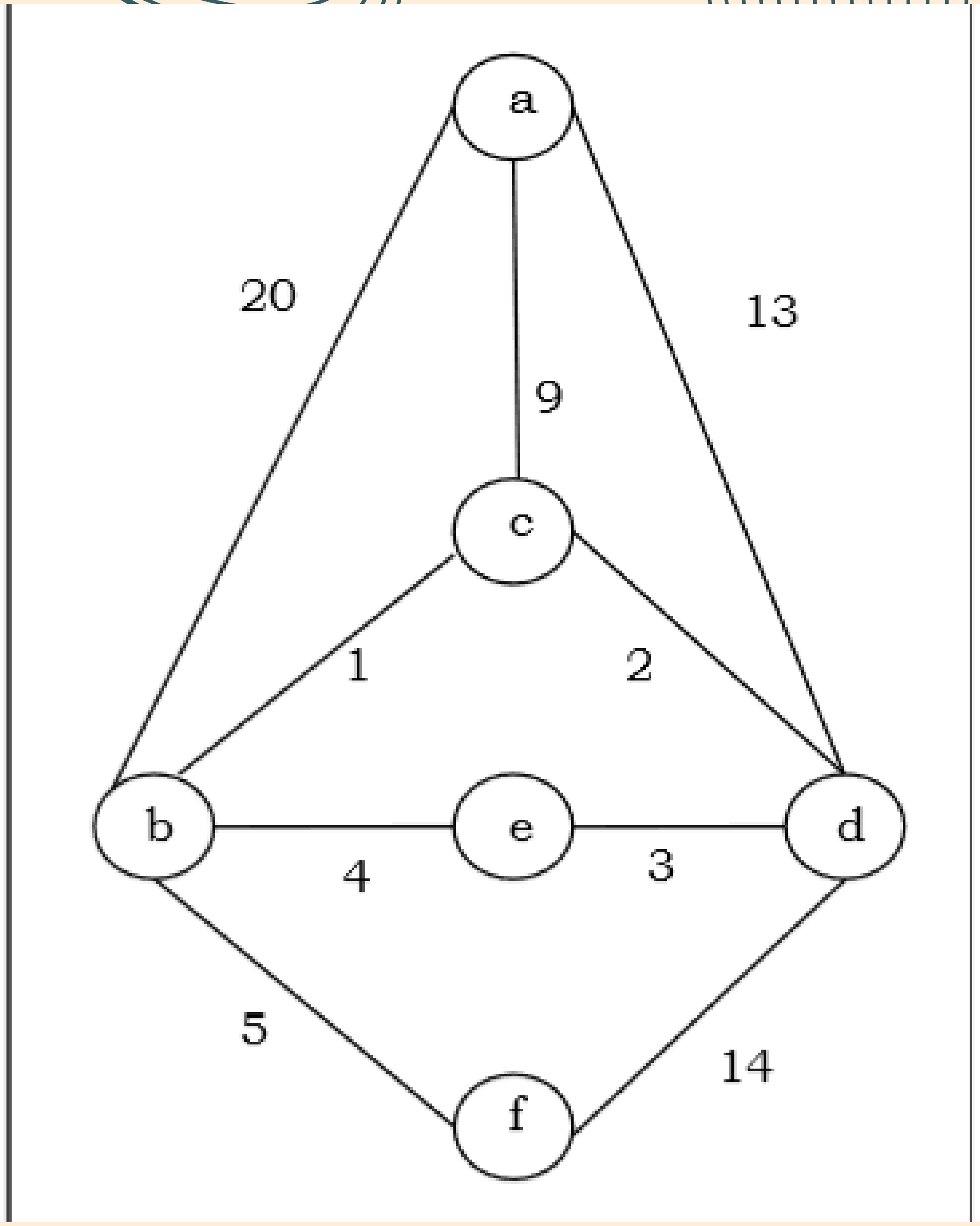
Minimum Spanning Tree.

Minimum Spanning Tree

Prim's Algorithm



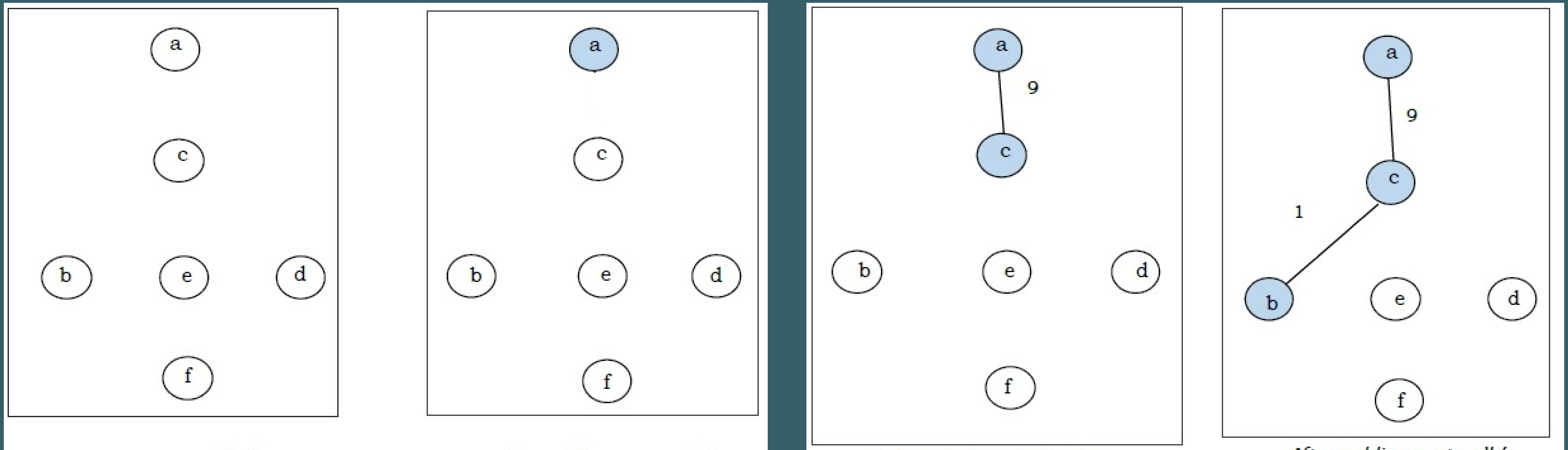
- Discovered in 1930 by mathematicians, Vojtech Jarnik and Robert C. Prim
- Used to find a minimum spanning tree for a connected weighted graph



Working of Algorithm:

1. Initialize the minimal spanning tree with a single vertex, randomly chosen from the graph.
2. Repeat steps 3 and 4 until all the vertices are included in the tree.
3. Select an edge that connects the tree with a vertex not yet in the tree, so that the weight of the edge is minimal and inclusion of the edge does not form a cycle.
4. Add the selected edge and the vertex that it connects to the tree.

We start with the vertex ‘a’ and proceed.

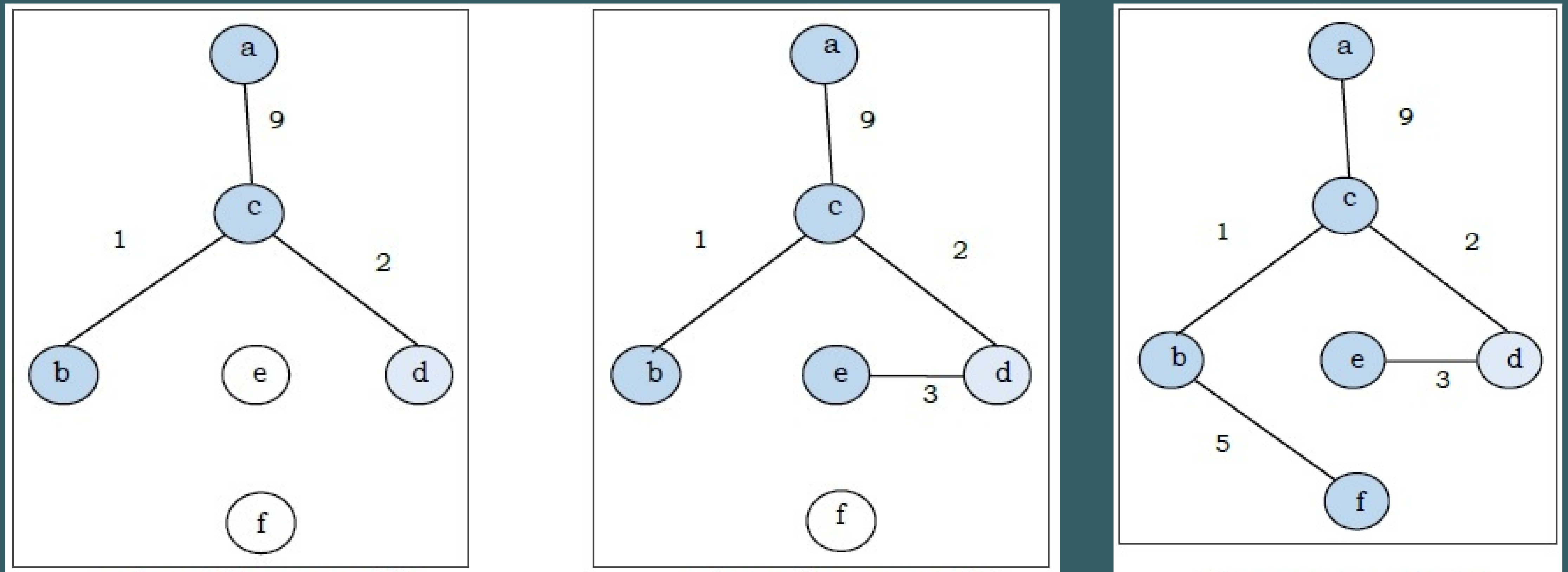


No vertices added

After adding vertex 'a'

After adding vertex 'c'

After adding vertex 'b'



After adding vertex 'd'

After adding vertex 'e'

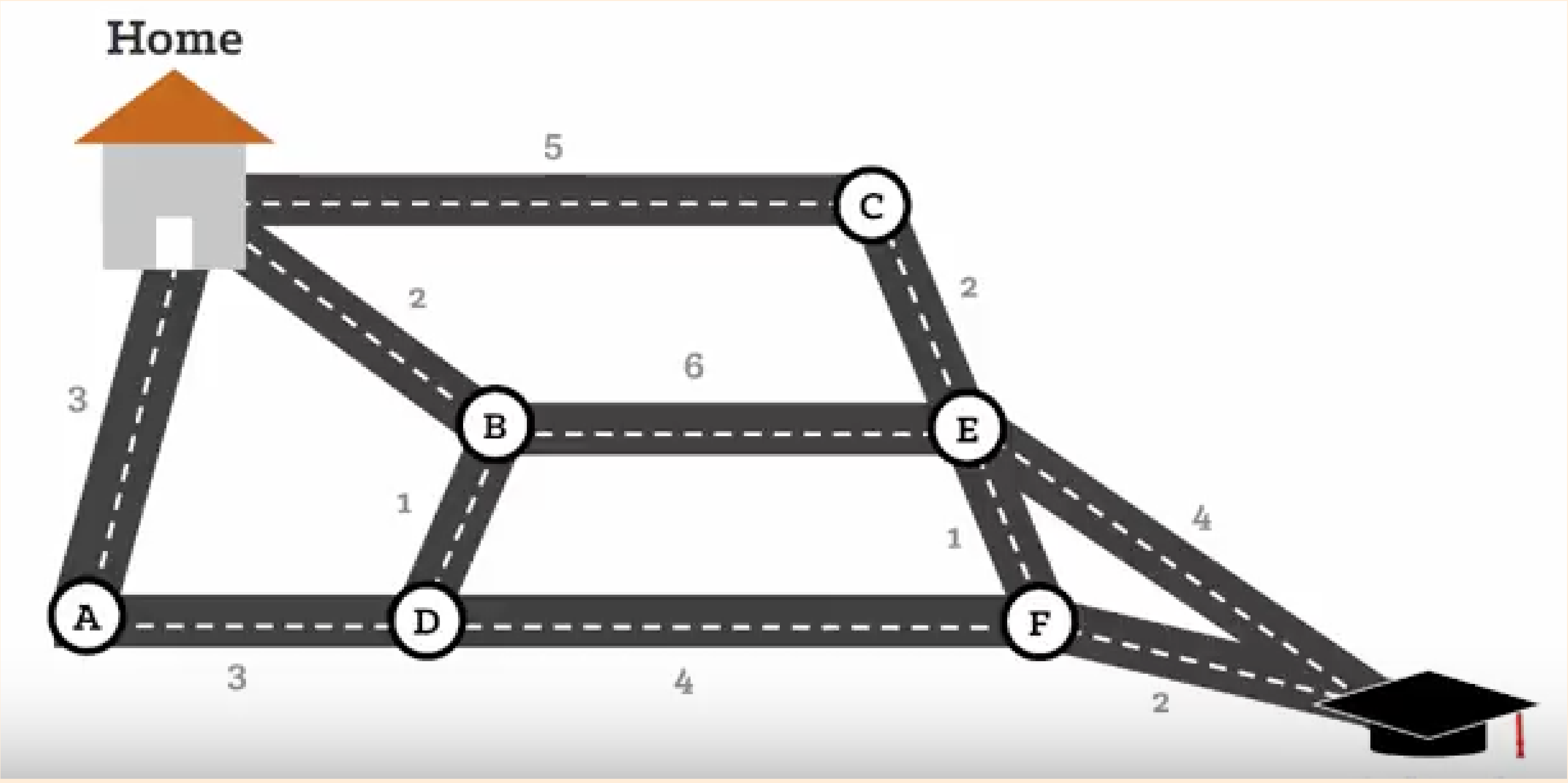
After adding vertex 'f'

This is the minimal spanning tree and its total weight is (1+2+3+5+9)=20

Dijkstra's Algorithm

Definition:

An algorithm that is used for finding the shortest distance, or path, from starting node to target node in a weighted graph



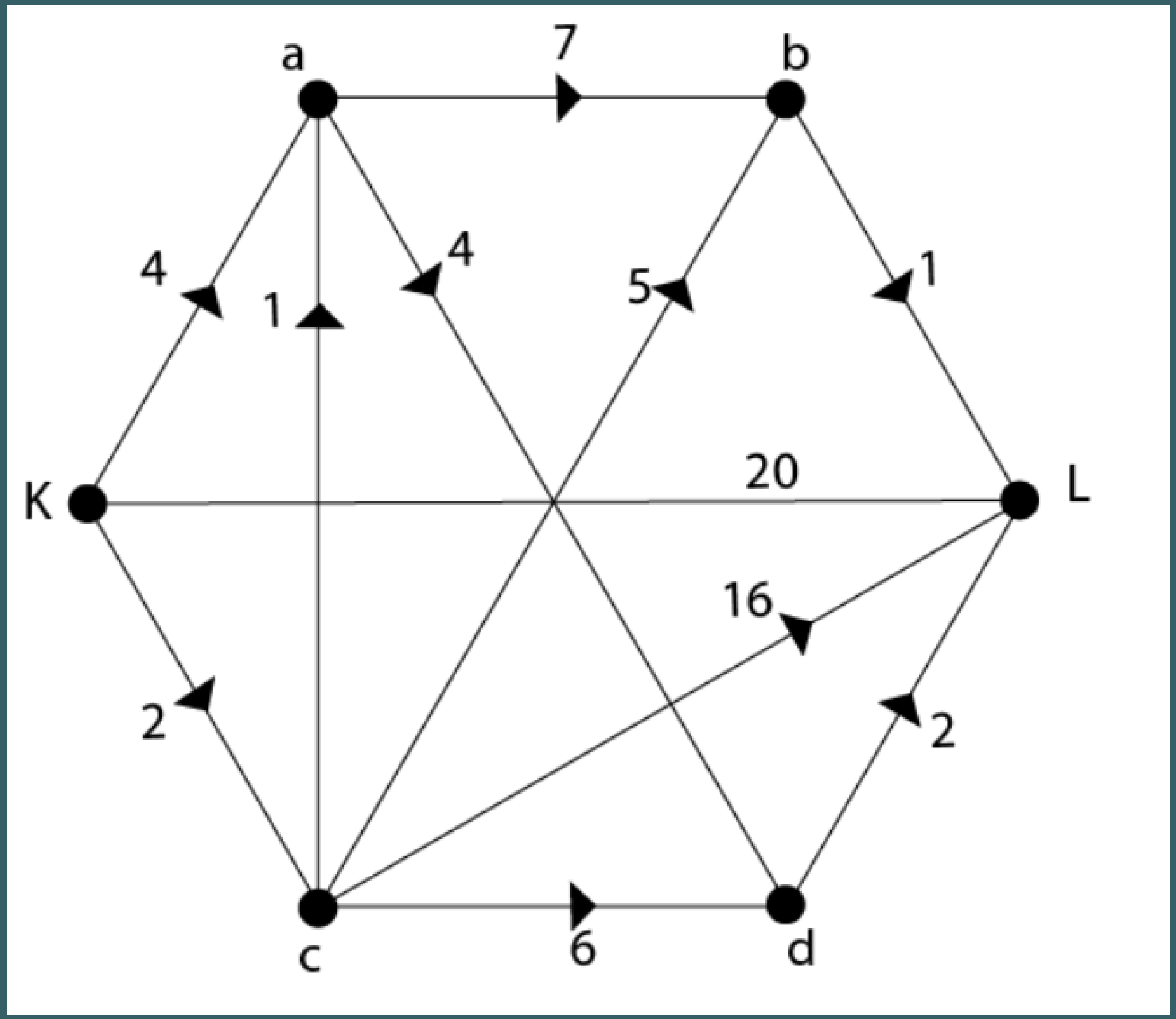
The shortest path, which could be found using Dijkstra's algorithm, is

Home → B → D → F → School.

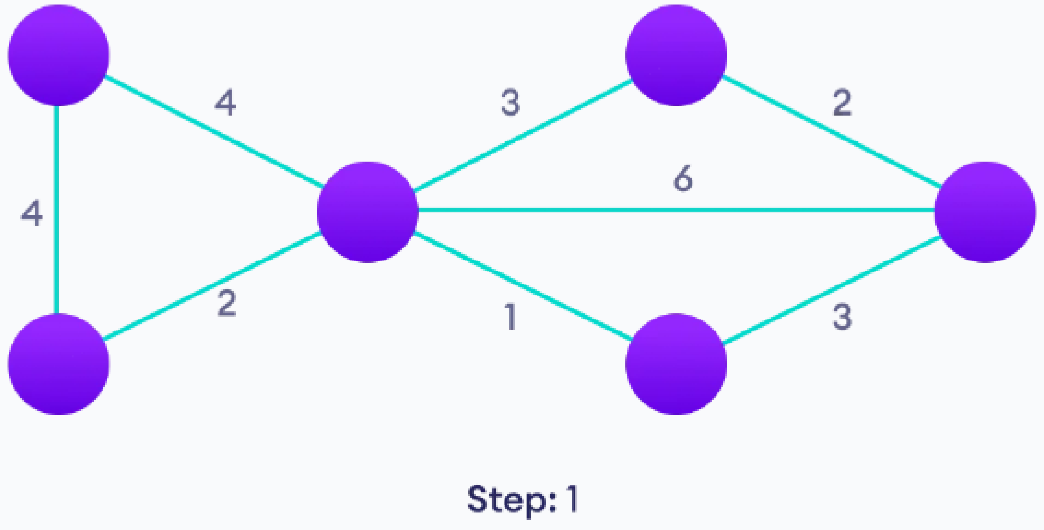
ALGORITHM

1. Initially, there is no vertex in sets.
2. Include the source vertex Vs in S.Determine all the paths from Vs to all other vertices without going through any other vertex.
3. Now, include that vertex in S which is nearest to Vs and find the shortest paths to all the vertices through this vertex and update the values.
4. Repeat the step until n-1 vertices are not included in S if there are n vertices in the graph.

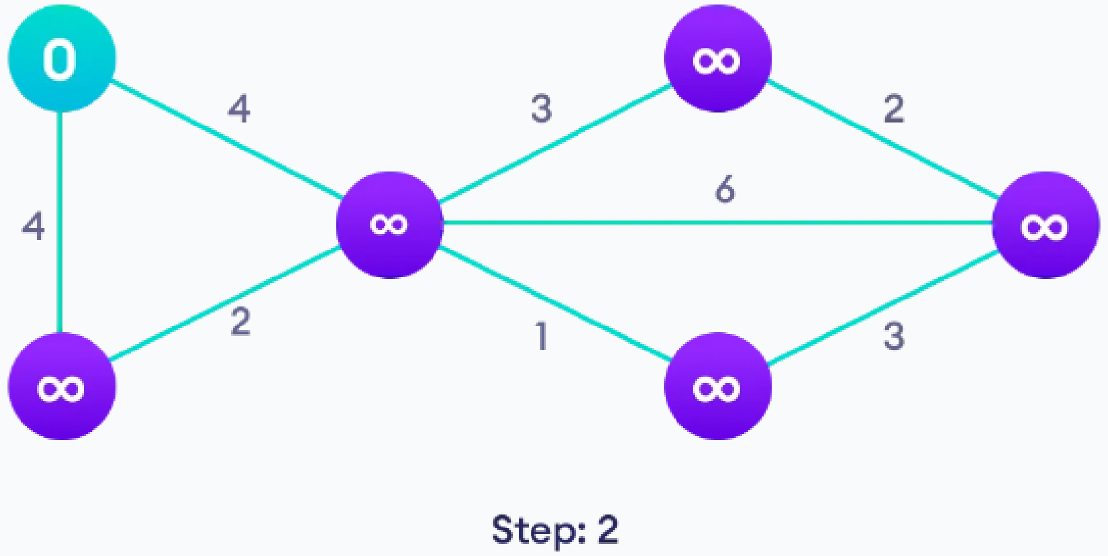
After completion of the process, we got the shortest paths to all the vertices from the source vertex.



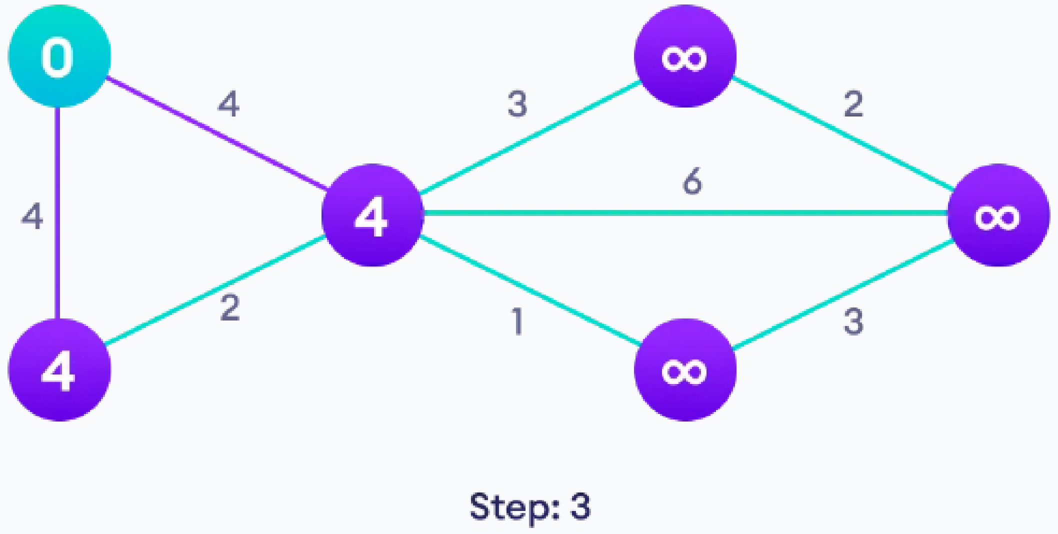
K - c - b - L



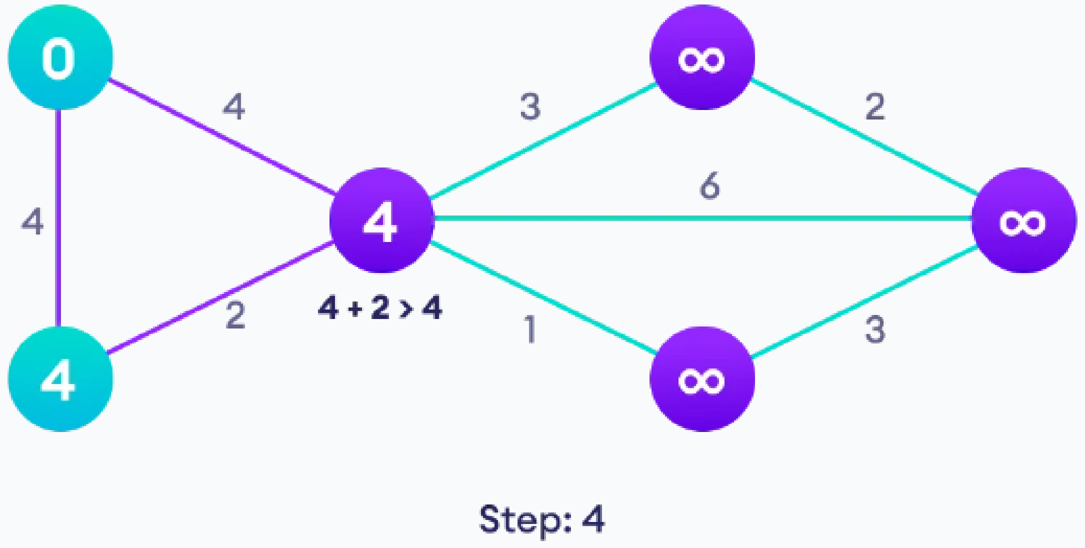
Start with a weighted graph



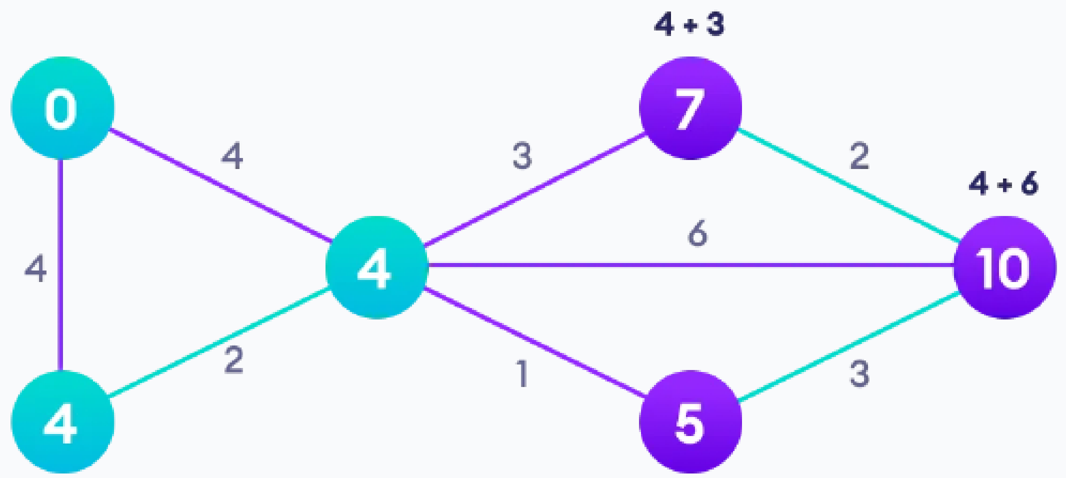
Choose a starting vertex and assign infinity path values to all other devices



Go to each vertex and update its path length

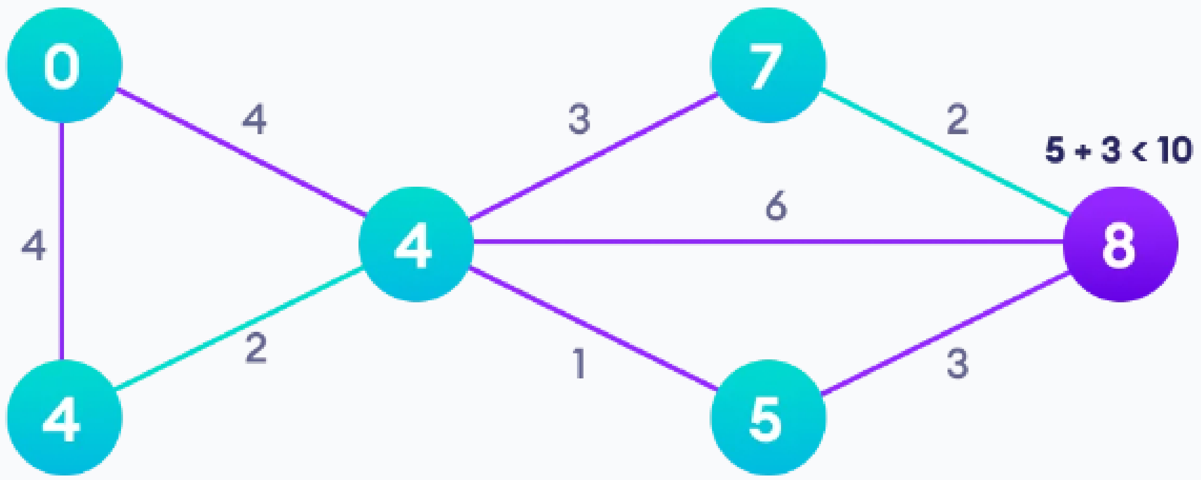


If the path length of the adjacent vertex is lesser than new path length, don't update it



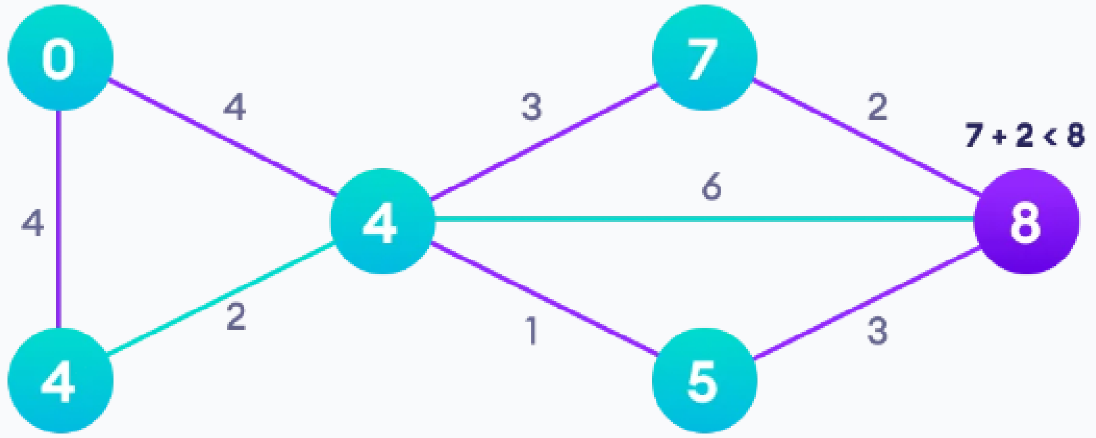
Step: 5

Avoid updating path lengths of already visited vertices



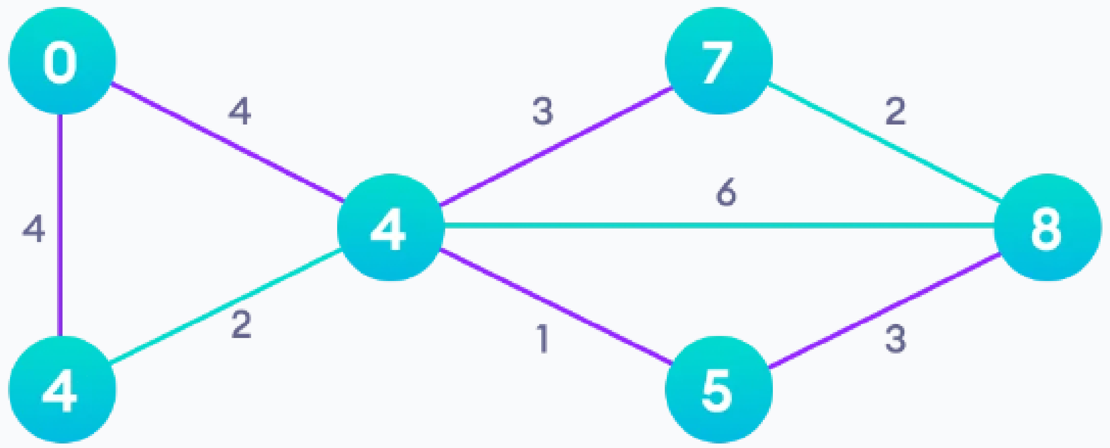
Step: 6

After each iteration, we pick the unvisited vertex with the least path length. So we choose 5 before 7



Step: 7

Notice how the rightmost vertex has its path length updated twice



Step: 8

Repeat until all the vertices have been visited

Thank You

Discrete Mathematics and Graph Theory
Slot: A21+A22+A23
Fall Semester 2022-2023