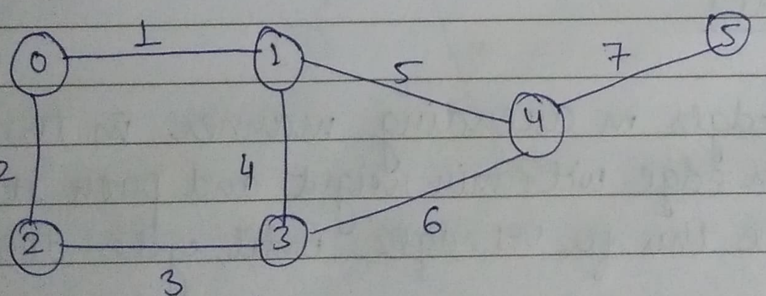
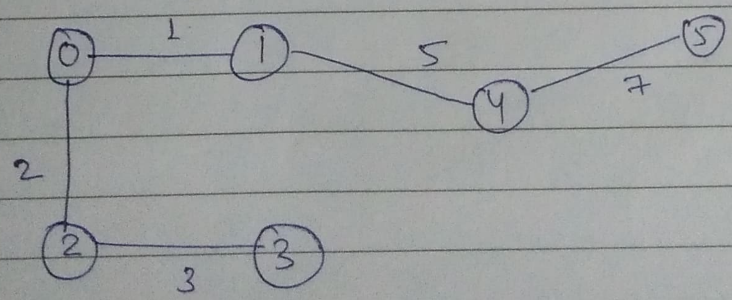
1. Minimal Spanning Tree:
It is a special kind of tree that minimises the length or weights of edges of the tree.
A tree is said to be spanning tree
- If it contains all the vertices.
- Spans all the vertices with n=1 edges.
- Is acyclic.

- A tree is minimum spanning tree if it spans the minimum weight while spanning all the vertices.

Applications:
1. Telephone
2. TV cable
3. Computer Networks
4. Constructing roads while spanning several areas | cities.





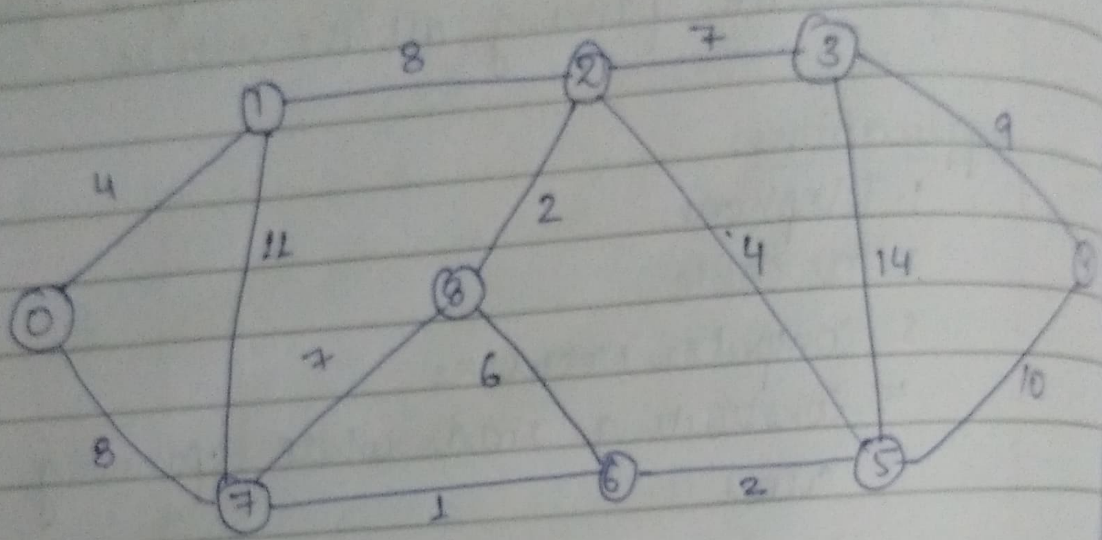
2. Time complexity

Kruskal's algorithm : $O(E \log V)$

Dijkstra's algorithm : Matrix - $O(n^2)$
Heap - $O(E \log V)$

Prim's algorithm Matrix - $O(n^2)$
Heap - $O(E \log V)$

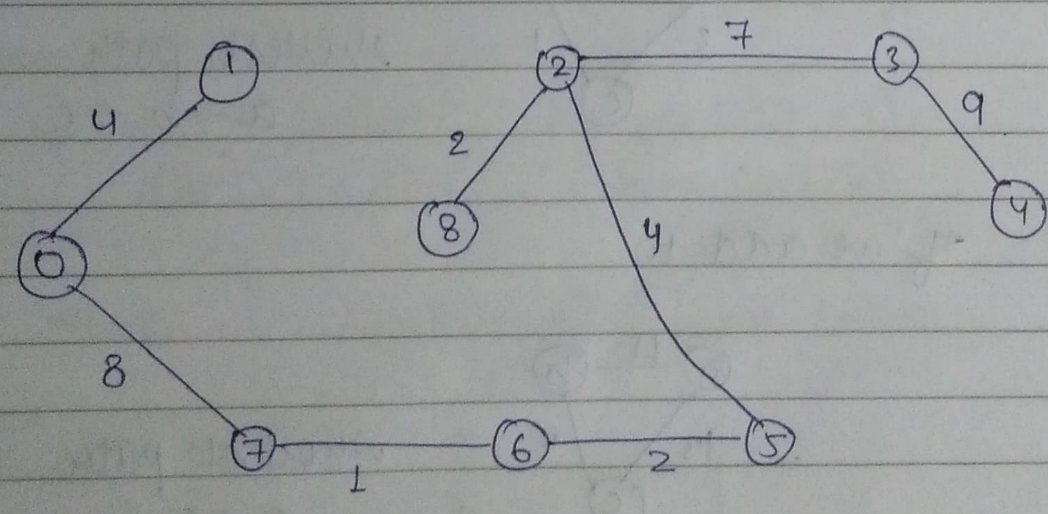
3.



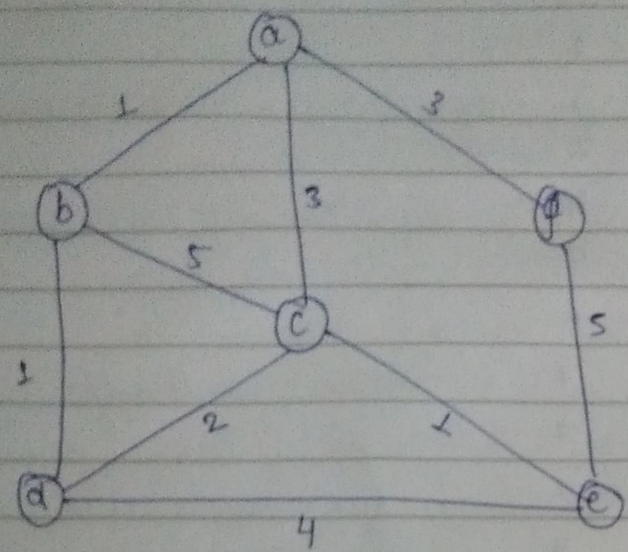
Krushkal's

- Sort edges in ascending manner in terms of weight
- Pick an edge with min weight and push it to result
- Continue this for V-1 edges until cycle does not come

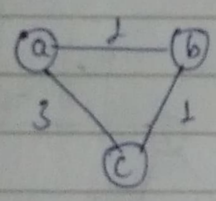
u	v	wt.
7	6	1
2	8	2
6	5	2
0	1	4
2	5	4
8	6	6
7	8	7
2	3	7
0	7	8
1	2	8
3	4	9
5	4	10
1	7	11
3	5	17.



4.

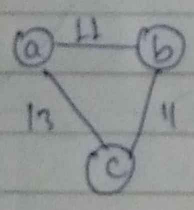


- If we add the weights of the graph by 10, Yes the shortest path can change then
  consider



shortest path
$a \to b \to c$

If we add 10

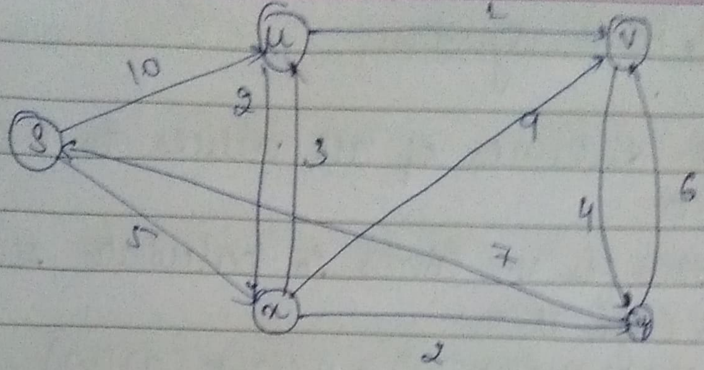


shortest path
$a \to c$

- There is no change in the shortest path if we multiply all the weights at edges by 10.

  If we multiply
  let $10N$ & $10M$
  if $N < M$
  $\Rightarrow 10N < 10M$.
  $\therefore$ No change

5.



Djkstra's algorithm:

- create sptset which keep track of vertices
- we assign all the vertices with distance infinite. Then we assign distance of source node to 0.
- while sptset does not include all the vertices.

i. Pick a vertex which is not sptset and has min distance
ii. Include it in sptset
iii. update distance value of all the adjacent vertices of the above vertex using condition.

if (dist [v] > dist [u] + graph [u][v])
  dist [v] = dist [u] + graph [u] [v]

Node	Shortest dist. from source.
s	0
u	8
x	5
v	9
y	7

Date:

Bellman's Ford's Algorithm:

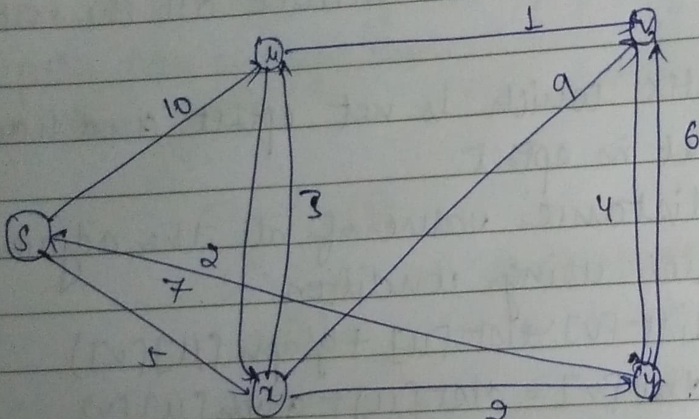
- Initialise distances of all vertices to 0 and assign dist[0] = 0.
- Repeat this for V-1 times to calculate shortest distance for each edge u-v.

  if (dist[v] > dist[u] + weight[u][v])

  dist[v] = dist[u] + weight[u][v].
- This will report if there is a negative weight.

  do this for each edge u-v.

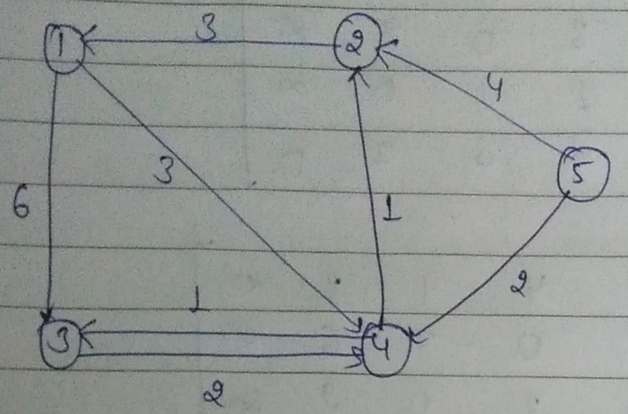
  if (dist[v] > dist[u] + weight[v][u])



(s,u) (s,x) (u,x) (u,v) (v,y) (y,v) (y,z) (l,m) (x,v) (x,y).

Node	shortest dist.
s	0
u	8
x	5
y	7
v	9

6. Floyd Warshall's



$$G = \begin{bmatrix} 0 & \infty & 6 & 3 & \infty \\ 3 & 0 & \infty & \infty & \infty \\ \infty & \infty & 0 & 2 & \infty \\ \infty & 1 & 1 & 0 & \infty \\ \infty & 4 & \infty & 2 & 0 \end{bmatrix}$$

$$G_1 = \begin{bmatrix} 0 & \infty & 6 & 3 & \infty \\ 3 & 0 & 9 & 6 & \infty \\ \infty & \infty & 0 & 2 & \infty \\ \infty & 1 & 1 & 0 & \infty \\ \infty & 4 & \infty & 2 & 0 \end{bmatrix}$$

$$G_2 = \begin{bmatrix} 0 & \infty & 6 & 3 & \infty \\ 3 & 0 & 9 & 6 & \infty \\ \infty & \infty & 0 & 2 & \infty \\ 4 & 1 & 1 & 0 & \infty \\ 7 & 4 & 13 & 2 & 0 \end{bmatrix}$$

$$G_3 \begin{bmatrix} 0 & \infty & 6 & 3 & \infty \\ 3 & 0 & 9 & 6 & \infty \\ \infty & \infty & 0 & 2 & \infty \\ 4 & 1 & 1 & 0 & \infty \\ 7 & 4 & 13 & 2 & 0 \end{bmatrix}$$

$$G_4 = \begin{bmatrix} 0 & 4 & 4 & 3 & \infty \\ 3 & 0 & 7 & 6 & \infty \\ 6 & 3 & 0 & 2 & \infty \\ 4 & 1 & 1 & 0 & \infty \\ 6 & 3 & 3 & 2 & 0 \end{bmatrix}$$

$$G_5 = \begin{bmatrix} 0 & 4 & 4 & 3 & \infty \\ 3 & 0 & 7 & 6 & \infty \\ 6 & 3 & 0 & 2 & \infty \\ 4 & 1 & 1 & 0 & \infty \\ 6 & 3 & 2 & 2 & 0 \end{bmatrix}$$