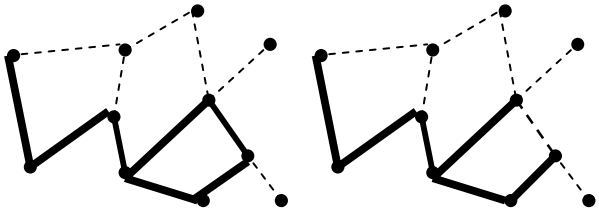
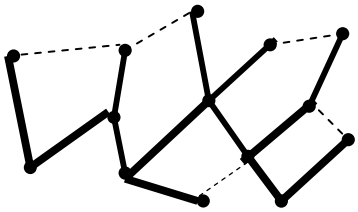
A **tree T** is a graph that is connected and has no cycles. (connected means there is a path between all vertices of T)



a cycle **a tree**

A spanning tree T in a graph is a tree containing all vertives of T.



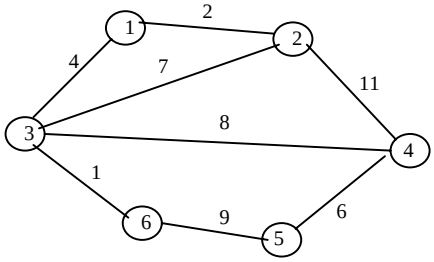
A spanning tree

A shortest spanning tree T in a graph is a spanning tree for which sum of all edges of T is minimum compared to any other spanning tree in that graph.

Algorithm Krustal, for shortest spanning tree.

1. Order the edges in ascending order of length
2. Chose them in this order as edges of T, reject an edge if only it forms a cycle.

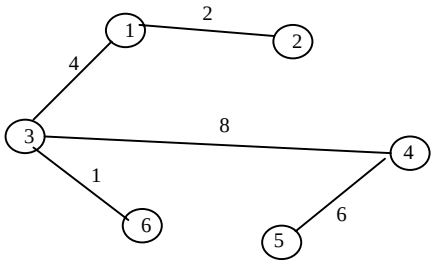
Example: Find the shortest spanning tree



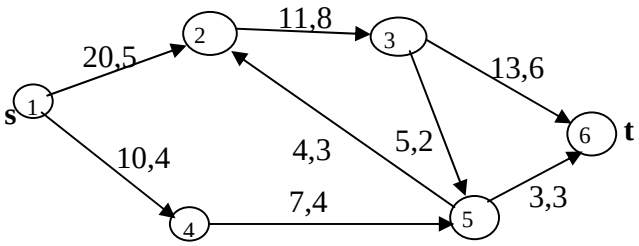
1

Solution:

(3,6)	(1,2)	(1,3)	(4,5)	(2,3)	(3,4)	(5,6)	(2,4)
1	2	4	6	7	8	9	11



A Network is a diagraph in which each edge has assigned to it a capacity (maximum flow)



First number: capacity **($C_{i,j}$)**
Second Number: given flow **($f_{i,j}$)**
S: source **t:** target
Path: sequence of edges in a diagraph

Flow augmenting path: Paths from S to t.
Examples: Path 1=(1-2-3-6) Path 2=(1-4-5-6)
Path 3=(1-4-5-3-6)

Forward edge: If the direction of path is the same as the direction of edge it is called forward edge.

Backward edge: If the direction of path is the opposite of the direction of edge it is called forward edge.
Path 1: 1-2, 2-3, 3-6 all forward edges
Path 3: 1-4, 4-5, 3-6 forward edges **5,3** backward edge

C_{ij}=the capacity of edge from i to j
f_{ij}=The value of current flow from i to j.
Δ_{ij}=possible additional flow from edge i to j.
$\Delta_{ij} = C_{ij} - f_{ij}$
Δ_{12} =20-5=15, Δ_{23} =11-8=3, Δ_{34} =13-6=7,
Δ_{14} =10-4=6, Δ_{45} =7-4=3, Δ_{56}=3-3=0,
Δ_{35}=5-2 =3.

Maximum Flow: Maximum possible flow from **s** to **t**
Kirchof's rule: Incoming flow=Outgoing flow
Example: for vertex 2, 5,3 incoming flow.
8:outgoing flow.. 5+3=8

Possible additional flow in path 1
We can increase maximum flow by 3 because the edge 2,3 allows only 3.

No additional flow is possible in path 2, because Δ_{56}=0, additional flow is possible in path 3.