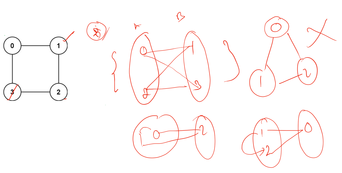
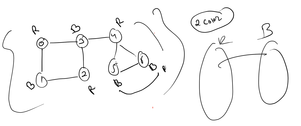
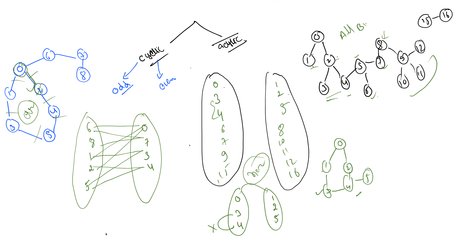
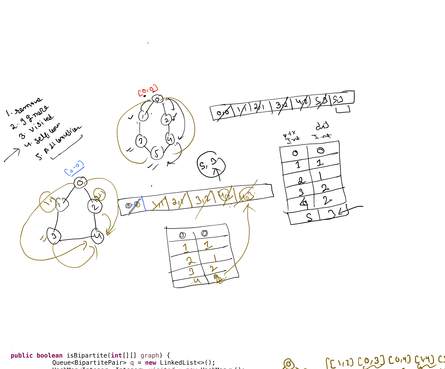




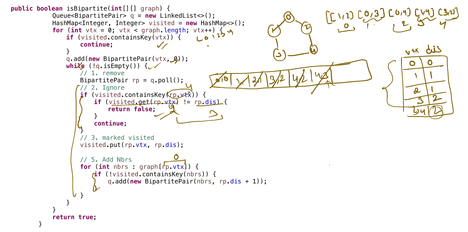




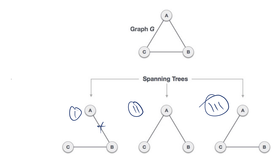

```
public boolean isBipartite(int[][] graph) {
        Queue<BipartitePair> q = new LinkedList<>();
        HashMap<Integer, Integer> visited = new HashMap<>();
        for (int vtx = 0; vtx < graph.length; vtx++) {
            if (visited.containsKey(vtx)) {
                continue;
            }
            q.add(new BipartitePair(vtx, 0));
            while (!q.isEmpty()) {
                // 1. remove
                BipartitePair rp = q.poll();
                // 2. Ignore
                if (visited.containsKey(rp.vtx)) {
                    if (visited.get(rp.vtx) != rp.dis) {
                        return false;
                    }
                    continue;
                }

                // 3. marked visited
                visited.put(rp.vtx, rp.dis);

                // 5. Add Nbrs
                for (int nbrs : graph[rp.vtx]) {
                    if (!visited.containsKey(nbrs)) {
                        q.add(new BipartitePair(nbrs, rp.dis + 1));
                    }
                }
            }
        }
        return true;
    }
```



A spanning tree is a subset of Graph G, which has all the vertices covered with minimum possible number of edges. Hence, a spanning tree does not have cycles and it cannot be disconnected..

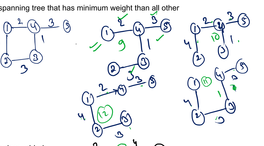


Properties of Spanning Tree

- A connected graph G can have more than one spanning tree.
- Spanning Tree has n-1 edges, where n is the number of Node (Vertices)
- All possible spanning trees of graph G, have the same number of edges and vertices.
- The spanning tree does not have any cycle (loops).
- Removing one edge from the spanning tree will make the graph disconnected, i.e. the spanning tree is minimally connected.
- Adding one edge to the spanning tree will create a circuit or loop, i.e. the spanning tree is maximally acyclic.

Minimum Spanning Tree (MST)
In a weighted graph, a minimum spanning tree is a spanning tree that has minimum weight than all other spanning trees of the same graph.
Kruskal's Algorithm

Prim's Algorithm
Both are greedy algorithms.



Consider the following graph:

Which one of the following is NOT the sequence of edges added to the minimum spanning tree using Kruskal's algorithm?
(A) (b,e)(e,f)(a,c)(b,c)(f,g)(c,d)
(B) (b,e)(e,f)(a,c)(f,g)(b,c)(c,d)
(C) (b,e)(a,c)(e,f)(b,c)(f,g)(c,d)
(D) (b,e)(e,f)(b,c)(a,c)(f,g)(c,d)