

# CSEN703: Analysis and Design of Algorithms

## Assignment 3

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### Question 3:

Given an undirected graph, explain how you can determine whether it is a tree or not. What would be the running time?

Solution: An undirected graph is a tree if it satisfies these conditions:

1. There are no cycles.
2. It's connected, meaning there's no vertex that can't be reached from any other vertex.
3. It has  $V-1$  edges. (number of its edges is number of vertices-1, which makes it avoid cycles)

We can discover these properties by performing DFS. At the end, we check that all vertices have been visited. If any vertex wasn't visited during our search, then the graph is not connected and it can't be a tree.

During our search, we can check for the acyclic property. When we discover a vertex, we check if it has been visited already. If it has, we check if this vertex is the parent of our current vertex. If it's not, and there's an edge that joins the 2 vertices that connect to our current vertex, this means our graph is cyclic and can't be a tree.

Then, we can count the number of edges. If they're not equal to  $V-1$  (where  $V$  is the number of vertices in the graph), then it's not a tree.

The running time for this would be the running time of performing DFS, which is  $O(V+E)$ .