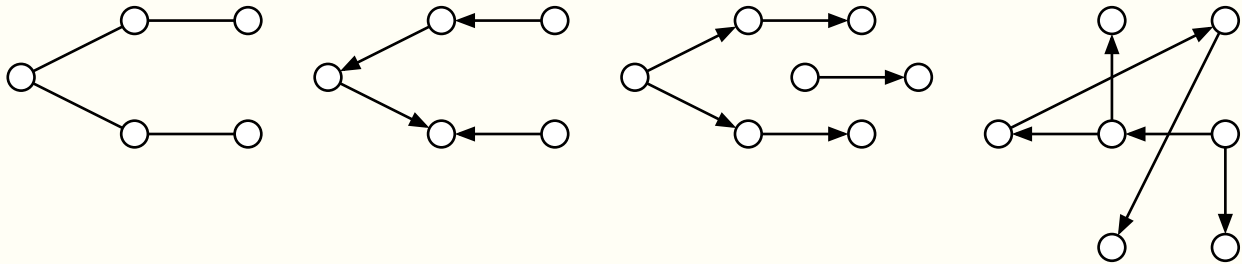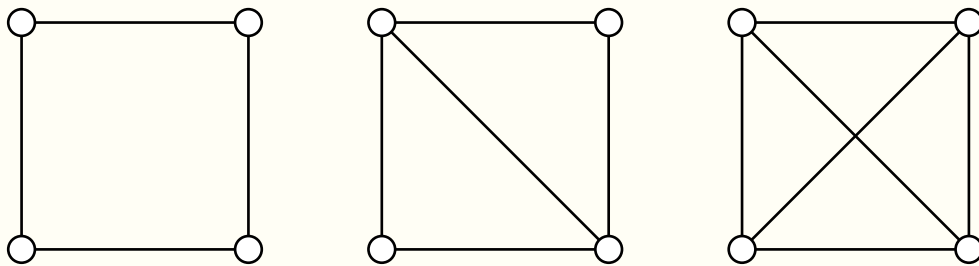# 4. Tutorial exercises - Third Series - Trees and arborescences

Exercise 1

1. Are the graphs below trees, forests, arborescences, or anti-arborescences?


2. Give the number of spanning trees for each of the following graphs:
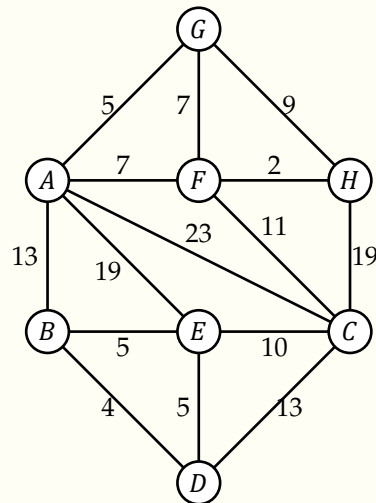

Exercise 2

In a telecommunication network, we want to develop a broadcast protocol. One node wishes to send a message to all nodes in his network. To make this possible, it sends the message to all of its neighbors, who then forward it to their neighbors, and so on. Each node should receive the message once. The following graph shows communication costs:
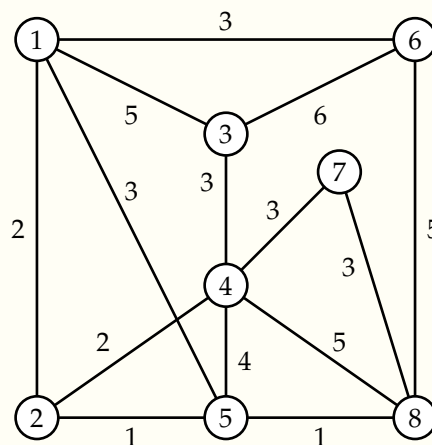
1. Show that this protocol requires building the minimum spanning tree of the graph.
2. Give the minimum spanning tree of the graph.
3. Make sure the spanning tree is a bipartite graph. Is this the case with any tree?

Exercise 3

We want to connect 8 departments $A, B, C, ..., H$ through a network of 8 terminals. Using Kruskal's algorithm, give a minimum spanning tree, then choose the best server site. The distances between departments are as follows:

Exercise 4

Consider the following graph. Explain how to build all minimum spanning trees by slightly modifying Kruskal's algorithm. Build them all.