# CSI5308 - Assignment 1 - INDIVIDUAL

**Due on OCTOBER 8**

— For all your algorithms: *the more efficient the solution, the better the mark.*
— In all exercises the *standard set of assumptions* are: total reliability, local orientation, bidirectional links. Read carefully to understand the additional assumptions and *do not use assumptions that are not given.* In particular: IMPORTANT: if it is not specified otherwise, there is an arbitrary number of initiators.
— In your solutions you can always use as a "building block" any of the algorithms that we have seen in class, without giving all the details.

**QUESTION 1** - The Algorithm below is executed in an arbitrary topology with a unique initiator, assuming the standard set of assumption and FIFO.

States S={INITIATOR, IDLE, ACTIVE, HAPPY}; Sinit = {INITIATOR, IDLE}; Sterm = {HAPPY}

**INITIATOR**
***Spontaneusly***
```
    init:= true
    happy-neighbours := { }
    send(How are you?) to N(x)
    counter:= 0
    become ACTIVE
```

**IDLE**
***receiving(How are you?)***
```
    init:= false
    myboss:= sender
    happy-neighbours := {sender}
    counter := 1
    if |N(x)| > 1 then
        send(How are you?) to N(x) – {sender}
        become ACTIVE
    else (* |N(x)| = 1 *)
        send(I-am-happy) to myboss
        become(HAPPY)
```

**ACTIVE**
***receiving(message)***
```
    if message = «I-am-happy» then
        happy-neighbours:= happy-neighbours ∪ {sender}
 counter := counter +1
 if counter = |N(x)| and I-am-not-init then
      send(I-am-happy) to myboss
      become(HAPPY)
 if counter = |N(x)| and I-am-init then
      become(HAPPY)
```

What does the algorithm achieve when every node is in the terminal state *HAPPY* ? Is termination local or global ? What is the exact message complexity of the algorithm ?

**QUESTION 2** - Consider a tree system with the standard set of assumptions, as well as FIFO. Assume each entity has associated a *salary* and a *gender*. Some external investigators want to know if all the entities with a *salary* below 50,000$ are female. Design a solution protocol that can be started by any number of initiators independently and terminates when every entity knows the answer. Write the pseudocode of your algorithm and analyze its message complexity.

**QUESTION 3** - Expand the rules of the saturation protocol so that it works correctly when the system is not FIFO. Write the pseudocode of your new protocol.

**QUESTION 4** - Consider an hypercube topology where the nodes know the topology. Assume the nodes are anonymous (i.e., they do not have distinct bit-names), but the edges are labeled with the usual dimensional labelling (as seen in class). Describe a traversal algorithm from a unique initiator with $O(n)$ message complexity. Describe your algorithm very clearly, derive its exact worst case message complexity, but **do not write the pseudocode**.

**QUESTION 5** - Consider a $k \times k$ mesh (also called grid) with $k \geq 5$ (see the Figure below for an example of a $5 \times 5$ mesh). In a mesh there are three types of nodes: corners, borders, and internal nodes: every internal node has degree 4, corners have degree 2, borders have degree 3. Assume that you have a mesh where, however, one node and all its incident links are missing. The nodes know that they are in a mesh with a missing node but they do not know which one. The nodes have distinct identifiers associated to them. Note that we are not assuming anything about the edge labels except that there is local orientation. Describe an algorithm to discover the orphan neighbours of the missing node: that is, when the algorithm terminates everybody must be in state *DONE*, and the nodes that were neighbours of the now-missing node must be aware of it. Analyze the complexity of your algorithm in the best and worst case. Describe your solution very clearly but **do not write the pseudocode**. Could you find a better solution making the assumption that *everybody is an initiator* ?