

Distributed Systems 18/09/2017
Corso di Laurea Magistrale in Ingegneria Informatica

☐ **5 Credits**

☐ **6 out of 12 Credits (not passed CNS yet)**

☐ **6 Credits**

☐ **6 out of 12 Credits (passed CNS)**

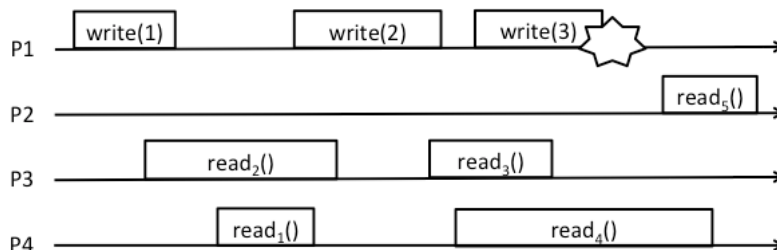
(tick the appropriate box above – write clear below)

Family Name _____ Name _____ Student ID _____

Ex 1: Concerning the problem of physical clock synchronization, explain the differences between internal and external clock synchronization.

Ex 2: Consider the Reliable, FIFO, Causal and Total Order broadcast primitives. Describe the relations (equivalence, orthogonality, inclusion) that exist among them, providing examples (runs) as a motivation to your answer.

Ex 3: Consider the execution depicted in the following figure and answer the questions



1. Define ALL the values that can be returned by read operations (Rx) assuming the run refers to a regular register.
2. Define ALL the values that can be returned by read operations (Rx) assuming the run refers to an atomic register.

Ex 4: Provide the specification of the Byzantine Consistent Broadcast communication primitive, describe an algorithm implementing it and discuss the relation between the number of processes n and the number of Byzantine failures f .

Ex 5: Consider a distributed system composed by n processes $\{p_1, p_2, \dots, p_n\}$ that communicate by exchanging messages on top of a ring topology.

Initially, each process knows only its left neighbour and its right neighbour and stores the respective identifiers in two local variables LEFT and RIGHT.

Processes may fail by crashing, but they are equipped with a perfect failure detection system that notifies at each process the new neighbour (when one of the two fails) through the following primitives:

- **Left_neighbour(p_x):** process p_x is the new left neighbour of p_i

- **Right_neighbour(p_x):** process p_x is the new right neighbour of p_i

Each process can communicate only with its neighbours.

The student answer to the following points:

- Write the pseudo-code of an algorithm implementing a Total Order Broadcast primitive assuming that channels connecting two neighbour processes are fair-loss links.
- Discuss which is the strongest Total order specification satisfied by the proposed algorithm.

According to the Italian law 675 of the 31/12/96, I authorize the instructor of the course to publish on the web site of the course results of the exams.

Signature: _____