**Instructions.** Each question is worth 6 points. Answer in English, Finnish, or Swedish. In questions 1–2, it is sufficient that you give an informal description of the algorithm—you do not need to use the precise state-machine formalism, and you do not need to prove that your algorithm is correct.

**Definitions.** An independent set of a graph $G = (V, E)$ is a subset of nodes $I \subseteq V$ such that there is no edge $\{u, v\} \in E$ with both $u \in I$ and $v \in I$.

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**Question 1: Deterministic algorithms.** Design a deterministic distributed algorithm that solves the following problem in time $O(\log n)$ in the LOCAL model:

- Graph family: cycle graphs.
- Local inputs: unique identifiers.
- Local outputs: a maximal independent set.

You can assume that the unique identifiers are integers between 1 and $n$. You can also assume that all nodes know $n$.

**Question 2: Randomised algorithms.** Design a randomised distributed algorithm that solves the following problem in the PN model:

- Graph family: cycle graphs.
- Local inputs: nothing.
- Local outputs: a maximal independent set.

**Question 3: Covering maps.** Prove that the following problem cannot be solved at all with deterministic distributed algorithms in the PN model:

- Graph family: cycle graphs.
- Local inputs: nothing.
- Local outputs: a maximal independent set.

You can use the following textbook result (without proving it): covering maps preserve local outputs.

**Question 4: Local neighbourhoods.** Prove that the following problem cannot be solved in time $o(n)$ with deterministic distributed algorithms in the LOCAL model:

- Graph family: cycle graphs.
- Local inputs: unique identifiers.
- Local outputs: a maximum independent set.

You can use the following textbook result (without proving it): isomorphic radius-$T$ neighbourhoods imply identical local outputs for time-$T$ deterministic algorithms.