Concurrency theory 2023/24 - topics for the oral exam

Petri nets

1. Equivalence of Petri nets, VAS and VASS.
2. The most important decision problems (reachability, liveness, coverability, boundedness).
3. An example of a safety property expressed as non-coverability.
4. Reduction of the coverability problem to the reachability problem.
5. Reduction of the coverability problem to place nonemptiness (whether a token can be placed in a given place).
6. Reduction of the reachability problem to place emptiness (whether a given place can be emptied).
7. Definition of regions and their use in the reconstruction of an elementary network from a configuration graph.
8. Definition of Mazurkiewicz traces.
9. Do elementary networks recognize all regular trace languages?
10. Definition of an asynchronous automaton.
11. Coverability tree - definition, applications.
12. The idea of proof of decidability of the reachability problem.
13. Computational complexity of the coverability problem.
14. Reachability problem when allowing negative token numbers. Equation of state.
15. Invariants. Example of a necessary condition expressible using invariants.
16. The continuous reachability problem and its computational complexity.
17. P-nets, T-nets, and free-choice nets.
18. Commoner's theorem: Characterizing liveness in free-choice networks.
19. Population protocols - definition.
20. What predicates are computable by population protocols?

Process algebra and bisimulation

21. CCS syntax and semantics.
22. Strong bisimulation equivalence - definition.
23. Prove that strong bisimulation equivalence is the greatest bisimulation.
24. Observational equivalence - definition.
25. Prove that observational equivalence is a congruence in CCS.
26. Simulation equivalence - definition.

27. Definition of strong/weak bisimulation equivalence using games.
28. The relationship between bisimulation equivalence and modal logic.
29. The relationship between modal logic and first-order logic.
30. Polynomial-time algorithm for bisimulation equivalence of finite-state processes.

You must briefly and concisely answer 3 questions selected by the examiner. Unless explicitly requested, no proofs are required, just knowledge of the definitions and statements of theorems.