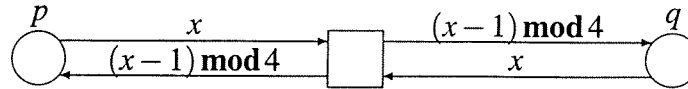
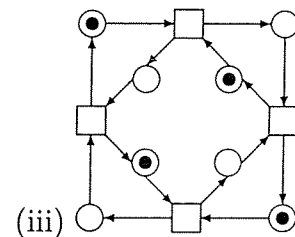
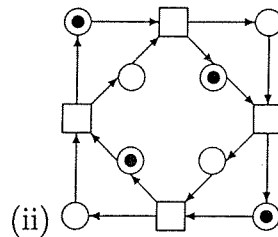
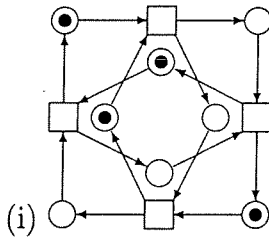


Submit at least one answer sheet, even if an empty one! Write onto *each* answer sheet you submit the information above, your name, student ID number, study programme, level, running number of the sheet and the total number of sheets you submit.

1. Nets



- (a) The above picture depicts a high-level net whose initial marking has not been specified. The markings of the places are multi-sets of the set $\{0, 1, 2, 3\}$. Which of the following place/transition systems corresponds to this net? (2p)

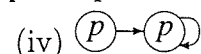
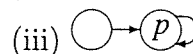
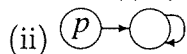
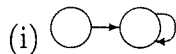


- (b) Copy the place/transition system to your answer sheet and label its places according to the places and values of the high-level net: $p_0, p_1, p_2, p_3, q_0, q_1, q_2, q_3$. Also label the transitions according to the values the variable x assumes. (2p)
- (c) Augment the high-level net with an initial marking corresponding to the place/transition system. (2p)

2. Construct the reachability graphs for all 3 place/transition systems of assignment 1. (6p)

3. Linear temporal logic (LTL)

- (a) Which of the following executions (i)–(iv) satisfy the formula $p \rightarrow \Box p$? Explain. (2p)



- (b) Specify 4 LTL formulae, such that each one holds in exactly one of the above executions. Example: the executions (ii)–(iv) must reject the formula that holds in (i). (4p)

4. Reachability analysis

- (a) Give examples of the applications for reachability analysis. (2p)
- (b) Why does reachability analysis consume so much memory space? (2p)
- (c) Present two methods of reducing the memory consumption. (2p)

5. Construct the incidence matrices of the 3 place/transition systems of assignment 1 and show with place invariants that the sum of the markings of the four “corner places” in each figure is constant. (6p)

6. Let there be two agents, $P ::= \alpha . \beta . P + \alpha . \gamma . P$ and $Q ::= \alpha . (\beta . Q + \delta . Q + \epsilon . Q)$.

- (a) Construct the labelled transition systems that correspond to P and Q . (3p)
- (b) Present a relabeling m that makes P and $Q[m]$ trace equivalent. (3p)