Please note the following: To pass the course you need at least 50% of the home assignment points. Please contact the Lecturer after the exam if you’ve not completed the home assignments successfully.

Assignment 1
Consider the following finite state automata $A_1$ and $A_2$, where $\Sigma_1 = \Sigma_2 = \{a, b\}$.

(a) Construct the finite state automaton $A_a = A_1 \cap A_2$.
(b) Construct the finite state automaton $A_b$ that accepts the complement of the language accepted by the automaton $A_a$.

Assignment 2
Consider the following three labelled transition systems (LTSs) $L_1$, $L_2$, and $L_3$:

(a) Compute the parallel composition $L = L_1 \parallel L_2 \parallel L_3$.
(b) Does $L$ contain any conflicts? If it does, please give a list consisting of all the triples $(v, t, t')$, where: $v$ is a global state of $L$ where a conflict occurs and $t, t'$ are a pair of global transitions of $L$ which are in conflict in $v$.
(c) Does $L$ contain any deadlocks? If it does, please give a list of global states of $L$ which are deadlocks.
(d) Does $L$ contain any livelocks? If it does, please give a list of global states of $L$ in which a livelock exists.
(e) Does $L$ contain a pair of independent transitions? If it does, give one example of two global transitions which are independent.
(f) Give a deterministic finite automaton $A_f$ accepting the language $\Sigma^* \setminus traces(L)$, where $\Sigma$ is the alphabet of $L$.
(g) Answer the question: Is $traces(L_1) \subseteq traces(L)$? Please use the automaton $A_f$ constructed in the previous step. If the answer is no, give a word in $traces(L_1) \setminus traces(L)$.

Note! More assignments on the other side of the paper.
Assignment 3  (a) Write a part of a Promela program that atomically swaps the values of two local variables \(x\) and \(y\). (The old value of \(x\) goes to \(y\) and vice versa.) Hint: you can freely use a temporary local variable \(tmp\) and you can assume all variables are of type \(\text{int}\).

(b) Give two LTSs \(L_b\) and \(L'_b\) such that \(L_b \leq_{tr} L'_b\) holds but \(L_b \leq_{\text{sim}} L'_b\) does not hold.

(c) Give two LTSs \(L_c\) and \(L'_c\) such that \(L_c \leq_{\text{sim}} L'_c\) holds but \(L'_c \sim L_c\) does not hold.

(d) Is the following claim true: If \(L_{d'}\) and \(L'_{d}\) are bisimilar then both \(L_{d'} \leq_{\text{sim}} L'_{d}\) and \(L'_{d} \leq_{\text{sim}} L_{d}\) hold. Please justify your answer using a sentence or two.

(e) Define formally the notion: “livelock”.

Assignment 4  Give the formalisation of the following properties as past safety formulas:

(a) Processes 0 and 1 are never at the same time in the critical section. Use atomic propositions: \(cs_0\) - process 0 is in the critical section, and \(cs_1\) - process 1 is in the critical section.

(b) If a lock is released, it has been locked in the past. Use atomic propositions: \(\text{release}\) - the lock is being released, and \(\text{lock}\) - the lock is being locked.

(c) If the alarm is on, the system has crashed in the past and has not been reset after crashing. Use atomic propositions: \(\text{alarm}\) - the alarm is on, \(\text{crashed}\) - the system crashed, and \(\text{reset}\) - the system is being reset.

Assignment 5  Create the reachability graph \(G\) of the P/T-net \(N\) below.

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The name of the course, the course code, the date, your name, your student id, and your signature must appear on every sheet of your answers.