

2G1516 Formal Methods

EXAMINATION PROBLEMS
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Give solutions in English or Swedish, each problem beginning on a new sheet. Write your name on all sheets. The maximal number of points is given for each problem. Textbook, copies of slides, other written course material and English dictionaries are admissible. Computers, mobile phones, other computing or communication equipment, is not.
Grades are given in the range F, 3, 4, 5 with the following cut-off points: 3: 50, 4: 70, 5: 85

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1. Exhibit a transition system T along with interpretation function η for the primitive state assertions a and b such that T satisfies the conjunction of the following four formulas: 15p

1. $\Box \langle \rangle a$
2. $\Box \langle \rangle b$
3. $\Box(a \rightarrow O(bUa))$
4. $\Box(b \rightarrow \neg a)$

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2. Produce a Buchi automaton accepting all ω -words $w \in \{a, b\}^\omega$ such that w_i (= the i 'th letter of w) is a whenever i is an even number. 15p

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3. For each of the LTL and CTL formulas below determine whether the initial state in the model of figure 1 satisfies the formula. Give a brief explanation in each case. 15p

1. $\Box(a \vee b)$
2. $aU(O(b \wedge \neg c))$
3. $bU(\neg bU(c \wedge Oc))$
4. $A(bU(E(\neg bU(c \wedge AXc))))$
5. $EFA((\neg b \wedge \neg c)Ub)$

Please Turn Over

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4. For each combination of precondition ϕ and postcondition ψ such that $\phi, \psi \in \{true, false\}$, determine the set of programs c such that c is partially correct w.r.t. ϕ and ψ . 10p

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5. Construct a transition diagram corresponding to the following while program c where x and y are integer variables: 15p

while $x > y$ do $(x := x - 2 ; y := y - 1)$

Construct a transition diagram corresponding to c . Use the extended inductive assertions method to prove that c is totally correct w.r.t. precondition $true$ and postcondition $true$.

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6. Let $P_1 = a.\tau.(b.0 + c.0)$, $P_2 = \tau.a.(b.0 + c.0)$, $P_3 = a.(\tau.(b.0 + c.0) + b.0)$. For each combination of $i, j \in \{1, 2, 3\}$ such that $i \neq j$ determine whether P_i and P_j are observationally congruent. Justify your answer by providing a suitable relation, or argue carefully why no such relation can exist. 15p

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7. Consider the following example of a bidirectional 1-place communication channel in CCS: 15p

$$Chan_{1,2} = in_1.\overline{out_1}.Chan_{1,2} + in_2.\overline{out_2}.Chan_{1,2}$$

By means of only relabelling, parallel composition, and restriction, use two copies of $Chan_{1,2}$ to construct a bidirectional 2-place channel. Is the resulting channel deadlock free? If it is not, revise the definition of $Chan_{1,2}$ to make it so.

Good luck!

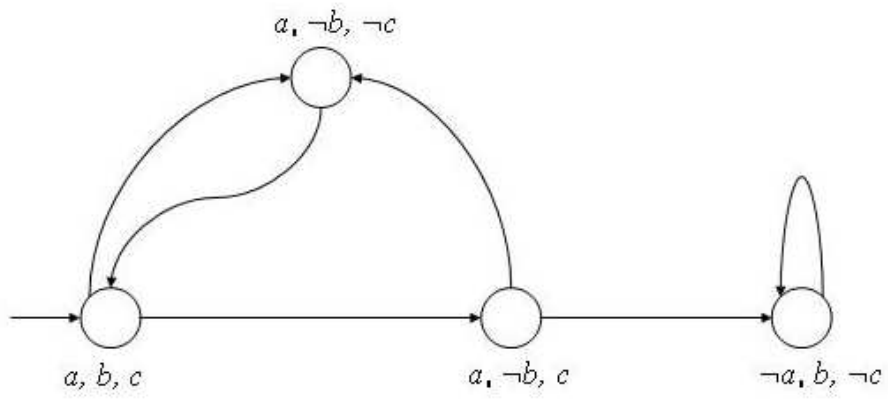


Figure 1: Model for question 3