Model Checking (VO) SS 2008 LVA 703521

First name: ______________________

Last name: ______________________

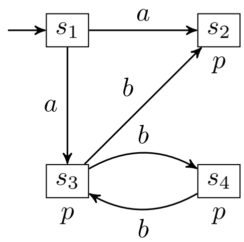
Matriculation number: ______________________

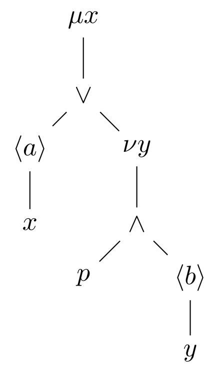
- Write your name and matriculation number on every page.
- Please answer all exercises in a readable and precise way. Please cross out solution attempts which are replaced by another solution.
- Cheating is not allowed. Everyone who is caught will fail the exam.
- Please do not remove the staples of the exam.

Exercise	Maximal points	Points
1	35	
2	30	
3	20	
4	15	
Σ	100	
Grade		

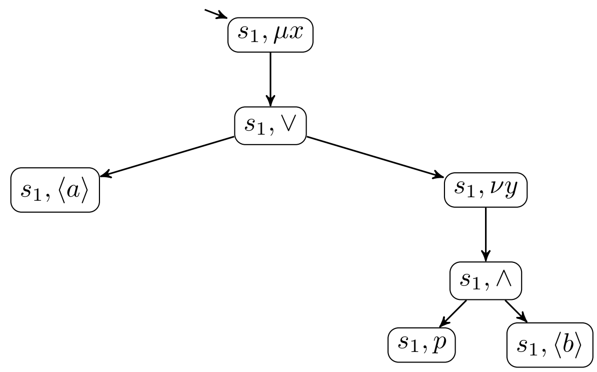
Exercise 1 (20 + 15 points)

Consider the following transition system and formula.



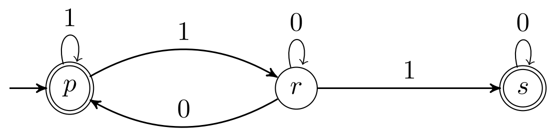


- Complete the game-graph which is depicted on the next page.
- Color the game-graph using the bottom-up coloring algorithm. Mark your nodes by (**g**)reen or (**r**)ed and additionally indicate whether a node was colored during a (**p**)ropagation-phase or whether it was colored since it remained (**w**)hite after propagation stopped. So, label each node with one of {**gp**,**rp**,**gw**,**rw**}.


$s_1, \mu x$
$s_1, \vee$
$s_1, \langle a \rangle$
$s_1, \nu y$
$s_1, \wedge$
s_1, p
$s_1, \langle b \rangle$

Exercise 2 (18 + 12 points)

Consider the following NBA $\mathcal{A}$.



- Compute the $\mathcal{A}$-equivalence classes by giving their shortest representatives and the corresponding transition profiles.

representative w	tp(w)

- Construct the S1S-formula $\varphi_{\mathcal{A}}(\mathsf{a})$ using the construction from the lecture (and not the optimized version from the exercises).

Exercise 3 (20 points)

Consider a crossing with two traffic lights, each having phases red-orange-green-orange-red-.... Construct timed automata TA_i ($i \in \{1, 2\}$) for each of the traffic lights such that the following conditions are satisfied:

- The combination of the lights is safe, i.e., if one light is in a non-red state, then the other light shows red.
- Each green phase is between 30 and 40 seconds long.
- There is a delay between 2 and 3 seconds after the switch from orange to red on the one light, before the switch from red to orange is performed on the other light.
- Each orange phase takes exactly 5 seconds.
- Both lights show green infinitely often.
- TA_1 and TA_2 are symmetrical, only the initial state differs: TA_1 starts in a red state, TA_2 in a green one.

For symmetry reasons you only have write down TA_1.

Exercise 4 (15 points)

The theorem of Knaster & Tarski can be lifted to infinite sets S. Essentially, one replaces $\tau^{|S|}(\varnothing)$ by

$$fp_\tau = \bigcup_{n \in \mathbb{N}} \tau^n(\varnothing).$$

Prove that if $\tau : 2^S \to 2^S$ is monotone then $fp_\tau \subseteq \tau(fp_\tau)$.