University of Innsbruck
3rd Exam

Institute of Computer Science
24 April 2008

Introduction to Model Checking (VO) WS 2007/2008 LVA 703503

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. Do *not* write with a pencil or a red pen. 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	**12**	
2	**24**	
3	**15**	
4	**19**	
Σ	**70**	
Grade		

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Exercise 1 (12 points)

Each correct answer is worth four points. A wrong answer results in zero points. Giving no answer is worth one point.

	Yes	No
The CTL formula $(\mathsf{A}\,\mathsf{G}\,\mathsf{A}\,\mathsf{F}\,\mathit{request}) \Rightarrow (\mathsf{A}\,\mathsf{G}\,\mathsf{A}\,\mathsf{F}\,\mathit{response})$ is equivalent to the LTL formula $(\mathsf{G}\,\mathsf{F}\,\mathit{request}) \Rightarrow (\mathsf{G}\,\mathsf{F}\,\mathit{response})$.		
Every language $L \subseteq \Sigma^\omega$ can be recognized by some NBA.		
Emptiness of $\mathcal{L}(\mathcal{A})$ for some GNBA $\mathcal{A}$ can directly be decided using an SCC-based analysis, without first translating $\mathcal{A}$ into some NBA.		

Exercise 2 (21 + 3 points)

Consider the following nanoPromela program which has two clients ($i \in \{1, 2\}$) which send their data via a scheduler to a printer. After a clients data $\mathtt{d}_i$ is delivered at the printer, client i gets an acknowledgement.

```
------- CLIENT i ------------
do :: true => ic ! i; dc ! d_i; ac_i ? ack od

------- SCHEDULER -----------
atomic { x := 0; d := "" };
do :: true => ic ? x; dc ? d; pc ! d; if :: x = 1 => ac_1 ! ack :: x = 2 => ac_2 ! ack fi od

------- PRINTER -------------
do :: true => pc ? d; skip od
```

- Construct the channel-system for the nanoPromela program.

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- Does the program contain a serious bug using asynchronous communication? If so, shortly describe it.

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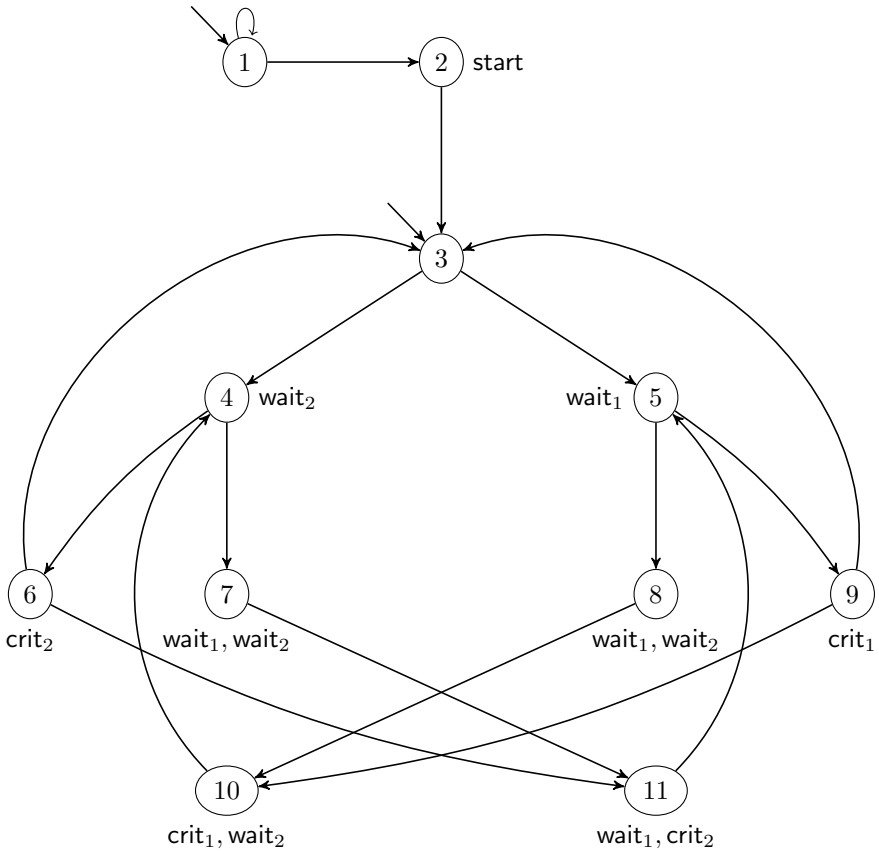
Exercise 3 (15 points)



Consider the above transition system TS of a mutual exclusion protocol and the following CTL*-formula Φ.

$$\Phi = (\mathsf{A}\,((\mathsf{F}\,\mathsf{G}\,\neg\mathsf{start}) \wedge \mathsf{A}\,(\neg\mathsf{wait}_1 \vee \mathsf{F}\,\mathsf{crit}_1))) \wedge \mathsf{A}\,\mathsf{F}\,(\mathsf{crit}_1 \vee \mathsf{crit}_2)$$

Does $TS \models \Phi$ hold? Justify your answer by performing CTL*-model checking, and write down $Sat(\Psi)$ for every state-subformula Ψ of Φ. Whenever one computes a set $Sat(\mathsf{A}\,\varphi)$, additionally write down the corresponding LTL-formula φ' that is checked. However, it is not necessary to perform LTL-model checking explicitly.

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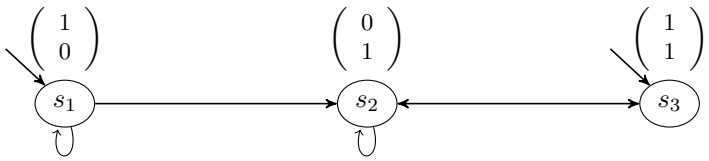
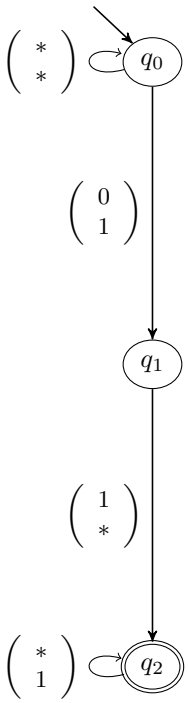
Exercise 4 (18 + 1 points)

Consider the following NBA $\mathcal{A}$ and the following transition system TS.





- Construct the NBA $\mathcal{B} = TS \otimes \mathcal{A}$ which accepts $\mathcal{L}(TS) \cap \mathcal{L}(\mathcal{A})$.
- Is $\mathcal{L}(\mathcal{B}) = \varnothing$? If not, then provide a word which is contained in $\mathcal{L}(\mathcal{B})$.