# Exam Theory of Automata and Processes (2IT15)

## 6 August 2008, 9.00 –12.00

Faculteit Wiskunde en Informatica
Technische Universiteit Eindhoven (TU/e)

This is a "closed book" exam. The parts add up to 100 points, the grade is obtained by dividing the total number of points by 10. *Motivate your answers!*

**Assignment 1** . Given is the following recursive specification:

$$
\begin{aligned}
S &\;\leftrightarrow\; 1 + a.T + a.U \\
T &\;\leftrightarrow\; \tau.V \\
U &\;\leftrightarrow\; 1 + b.V \\
V &\;\leftrightarrow\; b.U
\end{aligned}
$$

Give the non-deterministic automaton for $S$ given by the operational rules. Next, find a deterministic automaton without $\tau$-steps that accepts the same language as the automaton of $S$. Finally, give an iteration expression for this language. (20 points)

**Assignment 2** . Construct a pushdown automaton that accepts the following language:
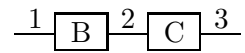$$ L = \{a^n b^{2n} \mid n \geq 0\}. $$
(17 points)

**Assignment 3** . Construct a Turing machine that accepts the following language:
$$ L = \{a^{2n} b^n \mid n \geq 0\}. $$
(17 points)

**Assignment 4** . Consider the language $L = \{a^n b^m a^n \mid n, m \geq 0\}$. Show by using the pumping lemma that this language is not regular. (20 points)

**Assignment 5** We consider two buffers, where messages along the connecting port may yield an error $\perp$. See the picture.

$$\underline{1}\;\boxed{B}\;\underline{2}\;\boxed{C}\;\underline{3}$$

Take the data set $D = \{0, 1\}$. The buffers $B$ and $C$ are given by:

$$
\begin{aligned}
B &= {?}_1 0.B_0 + {?}_1 1.B_1 \\
B_d &= \tau.!_2 d.B + \tau.!_2 {\perp}.B_d \quad \text{(for } d = 0, 1) \\
C &= {?}_2 {\perp}.C + {?}_2 0.!_3 0.C + {?}_2 1.!_3 1.C.
\end{aligned}
$$

a. Derive a recursive specification for the process $\partial_2(B\|C)$, and draw a transition system.

b. Consider the process $\tau_2(\partial_2(B\|C))$. Find a transition system without $\tau$-steps, that is branching bisimilar to this process. Notice that this process is equal to a two place buffer, which means this is a correct communication protocol.

c. Why does the equation of $B_d$ contain $\tau$'s? What can happen if they are omitted?

d. How can the system behave correctly, without the need for an acknowledgement going back (from $C$ to $B$)?

(26 points)