Assignment 1

a) Draw an automaton M (with no more than 4 states) that accepts the language $L = \{ a^n b^m \mid n, m \geqslant 0 \text{ and } n{+}m \text{ odd} \}$. (10 pts.)

b) Prove, by verifying two set inclusions, that $L = \mathcal{L}(M)$. (10 pts.)

Assignment 2

a) Give the definition of (strong) bisimulation of two terms x and y of $IA_\tau(\mathcal{N})$. (10 pts.)

b) Either prove that $(x \cdot x)^* \leftrightarrow x^* \cdot x^*$, for all processes $x \in IA_\tau(\mathcal{N})$, by providing a bisimulation relation and verifying that it is a bisimulation relation indeed, or disprove that $(x \cdot x)^* \leftrightarrow x^* \cdot x^*$ by providing a counter example and arguing why the respective processes cannot be bisimilar. (10 pts.)

Assignment 3

a) Formulate the Pumping Lemma for push-down languages. (10 pts.)

b) Prove that the language $L = \{ a^n b^n c^n \mid n \geqslant 0 \}$ is *not* push-down. (10 pts.)

Assignment 4 Consider the following processes of the process algebra $CA_\tau(\{P_1, P_2, Q_1, Q_2\})$, that includes parallel composition, the encapsultation operator and the abstraction operator:

$$\begin{aligned} P_1 &= \ell!1.a.P_1 \\ P_2 &= \ell!2.P_2 \\ Q_1 &= \ell?1.b.Q_2 \\ Q_2 &= \ell?2.Q_1 \end{aligned}$$

a) Give a derivation for the first transition of $\tau_\ell(\,\partial_\ell(P_1 \parallel P_2 \parallel Q_1)\,)$. (10 pts.)

b) Draw the transition system of $\tau_\ell(\,\partial_\ell(P_1 \parallel P_2 \parallel Q_1)\,)$ (10 pts.)

Assignment 5 Provide a Turing machine M with no more than seven states that is able to subtract binary numbers (of equal length and with positive outcome), i.e. give a Turing machine M that on input of the string $w{-}v$, outputs the binary number $w{-}v$, provided $w, v \in \{0,1\}^*$ are such that $|w| = |v| > 0$ and with the binary number w larger than the binary number v. (20 pts.)

The end marking of this exam is the total of accredited points divided by 10.