Aufgabe 1 (Regular Languages). (**??** Punkte)

(i) Which of the following claims hold? 3

(a) The language $L = \{a^k b^l \mid 1 \leq k \leq l\}$ is regular.

☐ Yes ☐ No

(b) The class of regular languages is closed under iteration (L^*).

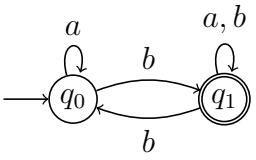
☐ Yes ☐ No

(c) For each three regular languages L_1, L_2 and L_3 it holds that $L_1 \cdot (L_2 \cup L_3) = (L_1 \cdot L_2) \cup (L_1 \cdot L_3)$.

☐ Yes ☐ No

(ii) Give a regular expression that describes the language of all words over $\{a, b\}$ in which the number of a's is even. 2

(iii) Apply the powerset construction to turn the following nondeterministic finite automaton (NFA) $\mathfrak{A}$ into a deterministic finite automaton (DFA) $\mathfrak{A}'$. 4



(iv) Is $\mathfrak{A}'$ minimal? Please justify your answer in the following way: 3

"yes": give a distinguishing word for each pair of states;

"no": give two equivalent states and explain why they are equivalent.

Aufgabe 2 (Context-Free Languages). (**??** Punkte)

(i) Which of the following claims hold? 3

(a) The language $L = \{a^n b^m c^m d^n \mid n, m \geq 1\}$ is context free.

☐ Yes ☐ No

(b) The class of context-free languages is closed under complement.

☐ Yes ☐ No

(c) Each context-free language can be recognised by some pushdown automaton.

☐ Yes ☐ No

(ii) Give a context-free grammar G which generates the language 4

$$L := \{a^k b^{2k} c^l \mid k, l \geq 1\}.$$

(iii) Give a derivation of the word $abbcc \in L$ from the start symbol of G. 1

(iv) Let G' be the following context-free grammar in Chromsky normal form: 5

$$\begin{aligned} S &\to AB \mid BA \\ A &\to BA \mid a \\ B &\to BB \mid b \end{aligned}$$

and let $w := bbbab$. Employ the CYK-Algorithm to show that $w \in L(G')$. Use the following table to compute the sets

$$N_{i,j} := \{A \in N \mid A \Rightarrow^* w[i,j]\} \qquad (1 \leq i \leq j \leq 5)$$

where $w[i,j] := a_i \dots a_j$ for $w = a_1 a_2 a_3 a_4 a_5$.

$i \backslash j$	1	2	3	4	5
1					
2	X				
3	X	X			
4	X	X	X		
5	X	X	X	X	