Name: ______________________

Student number: ______________________

Exercise 1 (Regular Languages). (12 points)

(i) Which of the following claims hold? $\boxed{3}$

(a) Deterministic finite automata (DFA) are strictly less expressive (i.e., describe less languages) than regular expressions.

☐ Yes ☐ No

(b) The class of regular languages is closed under union, intersection and complement.

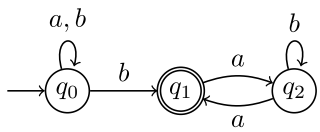
☐ Yes ☐ No

(c) The language $\{a^k b^l \mid k, l \in \mathbb{N}\}$ is context-free, but not regular.

☐ Yes ☐ No

(ii) Construct a regular expression that describes the language of all words over $\{0, 1\}$ that contain at least one pair of consecutive 0's and at least one pair of consecutive 1's. $\boxed{3}$

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



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

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

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

Name: ______________________________

Student number: ______________________

Exercise 2 (Context-Free Languages). (13 points)

(i) Which of the following claims hold? $\boxed{3}$

(a) The class of context-free languages is closed under union, intersection and complement.

☐ Yes ☐ No

(b) The language $\{a^k b^l c^m \mid k \geq l \geq m \geq 1\}$ is context-free.

☐ Yes ☐ No

(c) Given a context-free grammar G, it is decidable whether $L(G) = \emptyset$ or not.

☐ Yes ☐ No

(ii) Give a context-free grammar G which generates the language $\boxed{3}$

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

(iii) Give a derivation of the word $aabccc \in L$ from the start symbol of G. $\boxed{1}$

(iv) Let G' be the following context-free grammar: $\boxed{5}$

$$\begin{array}{lcl} S & \to & AB \mid BC \\ A & \to & BA \mid a \\ B & \to & CC \mid b \\ C & \to & AB \mid a \end{array}$$

and let $w := aabab$. 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	