17.1.2023

Sabancı University, CS 302 AUTOMATA THEORY

Fall 2023 - Final Examination

NAME:

NUMBER:

Closed (Book+Notes+All Electronic Devices)
Duration 150 minutes

Question 1 *(25 pts)*

(a) *(5 pts)*

State the definition of : (i) the transition function δ *; (ii) the extended transition function* δE *of a nondeterministic finite automaton (NFA)* A *and ; (iii) the language* L_A *accepted by* A *in terms of* δE *and the final state set* $F \subseteq Q$ *where* Q *is the state set of the NFA A.*

(b) *(10 pts) Sketch an NFA* X *that accepts the language* $L \subseteq \{0,1\}^*$ *where for every string* u *in* L *,* u *has no* ***substring " 01 "*** *.*

(c) *(10 pts) Compute a minimal state DFA* Y *that accepts the language* L *defined in part* ***(b)*** *above .*

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Question 2 *(25 pts)*

(a) *(12 pts) Write down a regular expression **E** over the alphabet set **{0,1}** such that **every** string **u** that has length **3 or more** in the language corresponding to **E** has a **substring of length 3** that has **2** or more **0**'s in it.*

(b) *(13 pts) Can you write down a regular expression **E** over the alphabet set **{0,1}** such that for every string **u** in the language corresponding to **E** the number of **0**'s and **1**'s in **u** differ at most by **1** ? If your answer is YES write down the corresponding regular expression **E** ; if it is NO then prove your result using an appropriate theorem.*

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Question 3 *(25 pts)*

(a) (*12 pts)* Convert the following *CFG* into *Chomsky Normal Form* (*CNF*) where ***S*** is the start symbol ; ***a,b,c***,and ***d*** are terminals and ***S,A,B*** and ***C*** are nonterminal variables.

$$S \rightarrow A \mid B \;;\; A \rightarrow aAb \mid C \mid e \;;\; C \rightarrow cCd \mid cC \mid e \;;\; B \rightarrow Bb$$

(b) *(8 pts) Using your CNF compute the steps of the leftmost derivation for the string*

w = aaccdbb

(c) *(5 pts) State the language* ***L*** *generated by the CNF in a simple logical notation.*

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Question 4 *(25 pts)*

(a) *(5 pts) Consider the language* $L_1 = (w \in \{a,b,c\}^* \mid w = a^n b^m c^k \; ; n > m \geq 0 \; ; k > 0)$
Is L_1 *a context-free language ? If so, compute a CFG to generate* L_1 *; if not use the pumping lemma to prove otherwise.*

(b) *(10 pts) Repeat part* ***(a)*** *for the language* $L_2 = (w \in \{a,b,c\}^* \mid w = a^p b^m c^k \; ; p = m \geq k \geq 0)$

(c) *(10 pts) Construct a single tape DTM* M *in graphical or tabular notation that decides the language* L_3 *below : (Initial ID: (s,* $\underline{\#}w$*))*

$L_3 = (w \in \{a,b,c\}^* \mid w = a^p b^m c^k \; ; p = m = k > 0)$