Sabancı University, CS 302 AUTOMATA THEORY

Spring 2023 - Final Examination

NAME:

NUMBER:

Closed (Book+Notes+All Electronic Devices)
Duration 120 minutes

Question 1 *(25 pts)*

(a) *(5 pts) Given a non-deterministic finite automaton (NFA)* $\boldsymbol{N = (Q, \Sigma, \delta, Q_0, F)}$ *specify (i) the domain and range of its extended transition function* **δE** *and (ii) define the language* $\boldsymbol{L \subseteq \Sigma^*}$ *accepted by* **N** *in terms of* **δE** *and* $\boldsymbol{Q_0}$ *and* **F**.

(b) *(8 pts) Consider the language* $\boldsymbol{L \subseteq \{0,1\}^*}$ *where for every string* **s** *in* **L** *of length greater or equal to* **2** *,* **s** *has a substring* **'11'**. *Write down a regular expression* **E** *corresponding to this verbally expressed language* **L**.

(c) *(12 pts) Construct an* ε*-NFA* **A** *, an NFA* **B** *,a DFA* **C** *and a* **minimal state** *DFA* **D** *that all accept* **L** *defined in part* ***(b)***.

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Question 2 *(25 pts)*

(a) *(9 pts) State the Pumping Lemma for Regular Languages .*

(b) *(8 pts) Consider the language* $\boldsymbol{L_1 = \{0^n 1^m \,;\, n.m}$ *= even number ,* $\boldsymbol{n,m \geq 0\}}$

State whether $\boldsymbol{L_1}$ *is a regular language or not. Justify your statement by either constructing an NFA that accepts* $\boldsymbol{L_1}$ *or a regular expression corresponding to* $\boldsymbol{L_1}$ *; or by using the pumping lemma.*

(c) *(8 pts) Repeat part* ***(b)*** *for* $\boldsymbol{L_2}$ *where*

$\boldsymbol{L_2 = \{0^n 1^m 0^k;\ n+k = m\ ,\ n,m,k \geq 0\}}$

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Question 3 *(25 pts)*

(a) *(7 pts) Define a* **deterministic** *push-down automaton (DPDA)*

$P = (Q, \Sigma, \Gamma, \delta, q_0, Z_0, F)$

(b) *(18 pts) Given the language* $L = (\omega \in \{0,1\}^* \mid \omega = 0^k 1^p 0^{2k} ; k > 0, p > 0)$

Construct a CFG **G** *in* **Chomsky Normal Form** *(CNF) generating the language* **L** *.*

(c) *(5 pts) Construct a DPDA* **P** *to accept* **L** *.*

(d) *(5 pts) Sketch the* **parse tree** *for the string* **0100** *based on your grammar* **G** *in CNF.*

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***Question 4** (25 pts)*

***(a)** (10 pts) Define a **non-deterministic** Turing Machine (NDTM) **M** (i) **deciding** and (ii) **semideciding** a language $\mathbf{L \subseteq \Sigma_0{}^*- \#}$.*

***(b)** (15 pts) Construct a DTM **M** in compositional tabular or a graphical form that **decides** the language: $\mathbf{L:=(\omega \in \Sigma_0{}^* \mid \omega = \omega^R)}$ where $\boldsymbol{\omega^R}$ denotes $\boldsymbol{\omega}$ in reverse with $\mathbf{\Sigma_0 \subseteq \Sigma - \{\#\}}$.*